COVISE

User's Guide

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COVISE User's Guide
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Contents

1 Introduction **7**
1.1 How **COVISE** works . . . 8
1.2 History . . . 9
1.3 First Steps . . . 9
1.3.1 Start Parameter . . . 10
1.3.2 Configuration File . . . 10

2 The Map Editor **13**
2.1 Menubar . . . 14
2.1.1 File Menu . . . 14
2.1.2 Execution Menu . . . 15
2.1.3 CSCW Menu . . . 15
2.1.4 Module Menu . . . 18
2.1.5 Tools Menu . . . 19
2.2 Available Help . . . 19
2.2.1 Tooltips . . . 19
2.2.2 What's this ? . . . 20
2.2.3 Online help . . . 20
2.3 Toolbar . . . 20
2.3.1 Toolbar Icons . . . 20
2.3.2 Favourites . . . 21
2.4 Module Browser . . . 21
2.5 Visual Programming Area (Canvas) . . . 23
2.5.1 Module Icon . . . 23
2.5.2 Module Actions . . . 24
2.5.3 How to move a module . . . 25
2.5.4 How to group modules . . . 25
2.5.5 Connecting Ports . . . 26
2.6 Module Parameter . . . 28
2.7 Control Panel . . . 30
2.8 Data Objects, Data Viewer . . . 31
2.9 Colormap Editor . . . 31
2.10 Settings . . . 33
2.11 Message Area . . . 34
2.12 Chat Line . . . 35

3 COVER **37**
3.1 Interaction . . . 37
3.1.1 Headtracking and 3D Pointer . . . 38
3.1.2 Stereo Viewing . . . 38
3.1.3 3D Menu . . . 39
3.1.4 Navigation Modes . . . 40
3.1.5 View Options . . . 44
3.1.6 Part Manipulation . . . 45
3.1.7 Animation . . . 45
3.1.8 COVISE . . . 46
3.2 Plug Ins . . . 47
3.2.1 Probe . . . 48
3.2.2 Viewpoints . . . 48
3.2.3 Snapshot . . . 49
3.2.4 Sketches . . . 50

4 The Renderer **53**
4.1 Introduction . . . 53
4.2 Getting started . . . 53
4.3 Cooperative Working Modes . . . 54
4.3.1 Using the Telepointer . . . 54
4.4 The Renderer's User Interface . . . 55
4.4.1 The Viewer Area . . . 56
4.4.2 The Menu Bar . . . 63
4.4.3 The Information Area . . . 80
4.5 Using Spaceball and Spacemouse . . . 81
4.6 Stereo Viewing Mode . . . 81
4.7 Head Tracking Mode . . . 81

5 Volume Rendering in COVISE **83**
5.1 Volume Rendering Basics . . . 83
5.1.1 Transfer Functions . . . 83
5.1.2 Rendering Technique . . . 84
5.2 COVISE Modules . . . 84
5.2.1 Module ReadVolume . . . 85
5.2.2 Module WriteVolume . . . 86
5.3 Desktop Renderer . . . 86
5.4 VR Renderer . . . 93
5.5 Volume file types . . . 100
5.6 Acknowledgments . . . 102

6 COVISE CE (Collaborative Engineering) 103
6.1 Architecture and Configuration . . . 103
6.1.1 Architecture Summary . . . 103
6.1.2 Distributed Computing . . . 104
6.1.3 Collaborative Working . . . 105
6.1.4 Preparing COVISE for a Distributed or a Collaborative Session . . . 106
6.1.5 COVISE across Firewalls . . . 106
6.2 CSCW . . . 107
6.2.1 CSCW Summary . . . 107
6.2.2 Including a remote host or partner in the session . . . 108
6.2.3 Starting a module on the remote computer . . . 111
6.3 MasterCtrl . . . 111
6.3.1 MasterCtrl Summary . . . 111
6.3.2 Master Request . . . 111
6.3.3 Synchronization . . . 114
6.3.4 Telepointer . . . 115
6.3.5 Chat Line . . . 116
6.4 Performance Considerations in a Cooperative Session . . . 116
6.4.1 Updating the Telepointer . . . 116
6.4.2 Direct Manipulation . . . 116
6.4.3 Using the Decoration Around the Viewer Area . . . 116
6.4.4 Using Sliders . . . 117
6.5 Mirroring . . . 117
6.5.1 Mirroring Summary . . . 117
6.5.2 Set Mirrors . . . 117
6.5.3 Mirror Nodes . . . 119
6.5.4 Delete Mirrored Nodes . . . 121
6.5.5 Example . . . 121
6.6 New Collaborative COVISE (Daemon) . . . 122
6.6.1 Concept of Collaborative COVISE . . . 122
6.6.2 Implementation . . . 125
6.6.3 Instructions for using the COVISE daemon . . . 128
6.7 Web Interface . . . 130

7 Batch Processing in COVISE 133
7.1 What does Batch Processing mean? . . . 133
7.2 Applications . . . 133
7.3 Implementation . . . 133
7.4 Mapping of COVISE to PYTHON . . . 134
7.5 How to begin? . . . 135
7.6 Python syntax . . . 137

7.6.1 Not COVISE related: 137
7.6.2 COVISE-related: 138
7.6.3 Mapping rules: COVISE - Python 138
7.6.4 Details of the Python net() object: 139
7.6.5 Details of the Python module objects: 139
7.7 One step forward - one step back 140

Organization of this Document

Chapter 1 gives you a brief overview of **COVISE**' architecture and history and shows you how to start it.

Chapter 2 shows you how to build your own module maps, to modify module parameter and how to work in a distributed and/or collabarative mode.

Chapter 3 gives you an introduction into the **COVISE** Virtual Reality renderer.

Chapter 4 makes the **COVISE** desktop renderer accessible to you.

Chapter 5 explains how to visualize volumetric data.

Chapter 6 details the colloborative features of **COVISE**.

1 Introduction

COVISE stands for **CO**laborative **VI**sualization and **S**imulation **E**nvironment. It is an extendable distributed software environment to integrate simulations, postprocessing and visualization functionalities in a seamless manner. From the beginning **COVISE** was designed for collaborative working, allowing engineers and scientists to spread on a network infrastructure. Processing steps can be arbitrarily distributed across different machine platforms to make optimal use of their varying characteristics. High speed network architectures of different kinds can be properly incorporated into **COVISE**. Industrial or research simulation codes are easily integrated into this distributed software environment by wrapping the code as a **COVISE** module. If required, the open design allows easy extension of the **COVISE** architecture.

None of the currently available visualization packages supports all of the following features availabe in **COVISE**.

- Distributed Working
- Supercomputer Usage (parallel or vectorized)
- Collaborative Working
- Integration of Custom Codes
- Virtual Reality
- Time Dependent Simulation

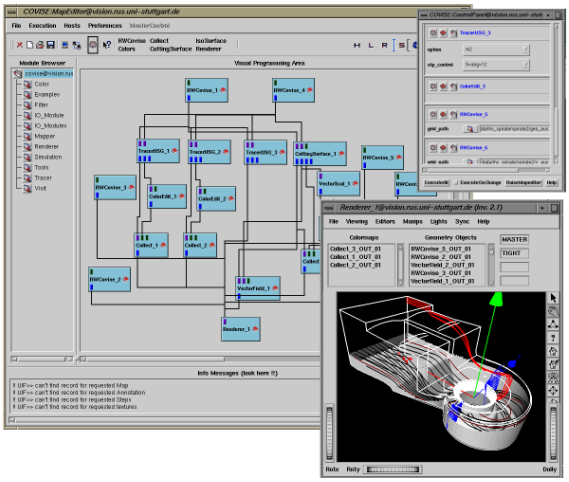


Figure 1.1: Visualization of Data with COVISE

COVISE is a modular and object-oriented software system. To visualize data several processing steps, called modules, are used. Each module is executed as a seperate operating system process and communicates with the central **Controller** and the local data request broker **CRB** by sending or receiving control messages via TCP/IP sockets. Modules are connected into a strictly unidirectional data flow network also called module map. Loops are not allowed, nevertheless, there are possibilities to send feedback messages from later to earlier modules in the processing chain. A Qt based user interface the **Map Editor** gives the user a tool to perform all the necessary interactions.

Data exchange is handled different from control flow. Within a machine pointers to shared memory are used to avoid copying of data objects. Between machines data objects are transferred by the **COVISE** request broker **CRB**, including necessary format conversions.

1.1 How COVISE works

Most visualization systems currently available focus on the visual programming paradigm in an algorithm-oriented way. Data itself cannot be accessed by the user directly, but exists only internally. Means are provided to connect modules to networks which perform certain visualization tasks, but the access to the underlying data mostly is limited to typing a filename in the input module.

There is no explicit control of data by users within most of the current dataflow based visualization systems. Thus either data produced by intermediate steps is kept even if it is not needed any more, or this caching mechanism can be switched off globally. As data does not exist as directly accessible data objects, selective handling is not possible. On the other hand a user who wants to examine a certain time interval repeatedly would be delayed by the application creating the same temporary objects over and over again instead of creating the sequence once and then displaying it just from cache.

Based on experience with own developments other packages available commercially or as open source, a system architecture has been designed which fits the needs of a high performance distributed visualization application.

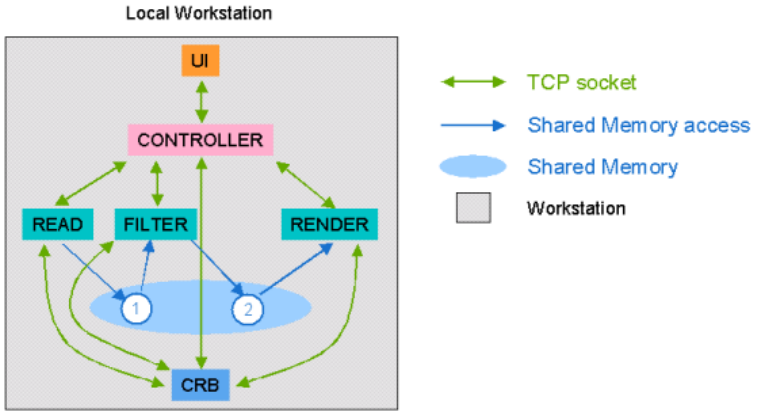


Figure 1.2: Local Working in COVISE

A modular approach allows for the most flexibility in distributing certain parts of the visualization application to specific computers. The need for excellent high speed network utilization makes it necessary to put emphasis on the management of the network connections depending on the nature of transferred data. The database approach makes a data request broker **CRB** necessary. This combination defines the **COVISE** architecture.

The **Controller** is the central part of this architecture. It has the overall view of the whole application. This **Controller** supervises the distribution of modules across the involved computers as well as the management of the execution of the application.

So an application module only needs connections to the **Controller** and the request broker **CRB**. The **Controller** supplies the application module with the information that is necessary to guarantee the proper execution of the overall application. The data that will be exchanged between subsequent application modules is stored under the control of the request broker **CRB**. This allows a very simple structuring of an application module.

The implementation of the **COVISE** system architecture is done in C++. The basic communication functionality is provided as a library.

For Distributed and Collaborative Working see Chapter 5, COVISE CE.

1.2 History

The development of **COVISE** was initiated in 1993 in the CEC RACE project R2031 named PAGEIN (Pilot Applications in a Gigabit European Integrated Network). The aim of PAGEIN was to evaluate possibilities of distributed computing and collaborative engineering on top of European high speed network infrastructures. One of the activities was the design and development of a software architecture as a testbed for the evaluation. The design of this basic architecture was led by the Visualization Department of the University of Stuttgart Computing Center (RUS). It was later called **COVISE**. Also the main components of **COVISE** as well as many application modules have been developed at RUS. With the project partners group from the aerospace field the application scenario was the simulation and analysis of air flow in the design phase of new airplanes. While initially industrial partners only defined their requirements they became more involved when they recognized the potential of CSCW (computer supported cooperative working) and **COVISE** for the engineering field.

As a result **COVISE** was used in the Esprit project ADONNIS (E9033) between Daimler-Benz Aerospace Airbus (DBAA, Bremen, Germany) and RUS (Stuttgart, Germany) via a 2 MBit/s leased line (permanent for one year). This allowed engineers of DBAA to evaluate cooperative working in an engineering simulation and design department.

In the project EFENDA sponsored by the German ministery of education and research BMBF the integration of modules from the airplane design field into **COVISE** as homogeneous software integration platform was performed to increase the productivity of the airplane developer.

In the final phase of the ADONNIS project a short demonstration of CSCW applied to the analysis of vibration simulations of satelites was given. This prove of concept led to the definition of an Esprit best practice and demonstration project ACATAD with CASA (CONSTRUCCIONES AERONAUTICAS SA Division Espacioas) as the primary industrial partner in which collaborative analysis of dynamic simulations among satellite producer and sub contractors is introduced. **COVISE** will be used across multiplexed ISDN lines.

Also the **COVISE** development was initated in the aerospace field the underlying concepts and architecture are independent of a certain application field. Thus it was possible to also apply **COVISE** to the automotive applications.

In the Esprit project (E20184) HPS-ICE, (High Performance Simulation of Internal Combustion Engines), INDEX (E22745), COVAS (E22542), the BMBF-project EFENDA, the G7-Projects SPOCK and GWAAT, the Collaborative Research Center (SFB374) and many other national projects.

Since 2004, the development of **COVISE** is a joint effort by HLRS at the University of Stuttgart and RRZK at the University of Cologne.

In 1997 the developers of **COVISE** founded the company **Vircinity IT-Consulting** to bring **COVISE** to the market. **COVISE** is now distributed by VISENSO GmbH.

1.3 First Steps

On Windows, a new **COVISE** session can be initiated from the Start menu or by Desktop icons. On UNIX systems, the installation process appends the path to the **COVISE** executables and modules to the environment variable $PATH. Thus, starting **COVISE** should be as easy as typing `covise` in a shell window. If the command `covise` is not found, please contact your system administrator.

Initiating a **COVISE** session will start the following processes:

1. **Controller** (`covise`)
2. **CRB** (`crb`)

3. **Map Editor** (`mapeditor`)

After the starting phase the **Map Editor** window will appear (see Fig.2.1).

1.3.1 Start Parameter

COVISE can also be started with parameters. Typing `covise --help` will show you the syntax.

The following start options may be useful for you:

- **-i** start with **Map Editor** as icon
- **-e** execute immediately after loading
- **-q** quit after 1st run (**only together with -e**)

1.3.2 Configuration File

COVISE has a central configuration file `covise.config`, which resides in the $COVISEDIR directory. The file consists of sections named *scopes*, which look like :

```
Scope-name { : hostname}
{
Var-Name1 string2
Var-Name2 string2
}
```

HostConfig

see also Chapter 5, COVISE CE) Each computer that will participate in a distribited or collaborative session must be included in the scope HostConfig. For each host the hostname, the memoy model, the execution mode and a timeout have to be set .

```
HostConfig
{
# Hostname   Shared Memory     execution mode      timeout [s] Min. SHM
#           (shm|mmap|none) (rexec|rsh|ssh|manual) (default 5)  segment
   mike          shm               ssh               360          32MB
   peter         shm               manual            360
   george        shm               rsh               360
}
```

For workstations and PCs the memory model is shm (shared memory). There are other memory models for supercomputers like CRAY.

When using shared memory, **COVISE** manages multiple shared memory segments and tries to put its data object in free spaces of these segments. If no memory is left, it will allocate an additional segment. The size of this segment is the minimum of the required ize for the object and the minimum allocation size specified in the config file.

Small minimal SHM segment sizes will reduce memory consumption, but increase the number of segments and add overhead. Both maximum size of shared memory usage and number of segments are limited by operationg system and machine configuration.

If no value is given, the following defaults are used:

```
Linux:              8 MB
SGI n32 and HP:    16 MB
SGI 64bit:         64 MB
```

UIConfig

The user interface looks for the scope UIConfig. The variable *ShortCuts* contains the name of favourite application module names. If the variable *ModuleIcons* is set to colored, module icons for different host have different colors on the **Map Editor** canvas.

```
UIConfig
{
ShortCuts  RWCovise Colors Collect CuttingSurface IsoSurface Renderer
ModulIcons colored
}
```

In addition, you can use UIConfig to specify a browser for displaying online help or other online documentation; default is

```
Browser        netscape
```

Please note that online help and documentation is optimized and tested with Netscape, so there might be minor problems with other browsers.

Additional information for using a MultiPC system:

In order to improve the performance of COVER under Linux, you can use 2 synchronized PCs running in parallel instead of 1 PC using a dual graphic card. One of them will be the master and will be connected to the tracking system. The PCs will be connected through TCP/IP and serial connection. The serial cable will be plugged into one of two serial ports which has to be specified in cover.config, section MultiPC, key "Serial_Port". Master and Slave (names of the machines) are defined in the same section. In addition, you have to define the type of connection between the hosts in covise.config, section HostConfig (like in collaborative working).

Example:

```
HostConfig
{
#  Hostname    Shared Memory    execution mode    timeout in seconds

      pc1         shm               rsh               -1

      pc2         shm               rsh               -1
}

MultiPC
{
    Master        pc1
    Slave         pc2
    Serial_Port  /dev/ttyS0
}
```

License

A very important scope in the configuration file is the license key. Without such a key no **COVISE** can be started.

```
License
{
Key NFLHOODOLEBLILIEDEMLMNJGAJDPPHHHCDCIDPGDHABJKAKN    visage    31.12.2001
}
```

Most of the currently existing scopes are mainly used by the controller, the user interface, the desktop renderer and the VR renderer. You can find more details about single scopes in the chapters explaining these central **COVISE** parts.

2 The Map Editor

This chapter explains the usage of the **COVISE Map Editor**, how to work with modules, connect module ports to a map and modify module parameters. After reading this chapter you should be able to visualize your data within **COVISE**.

The graphical user interface is based on the **Qt** software from **Qt** (http://www.trolltech.com). After typing `covise` on a command line or clicking on a covise icon the **Map Editor** top level window appears.

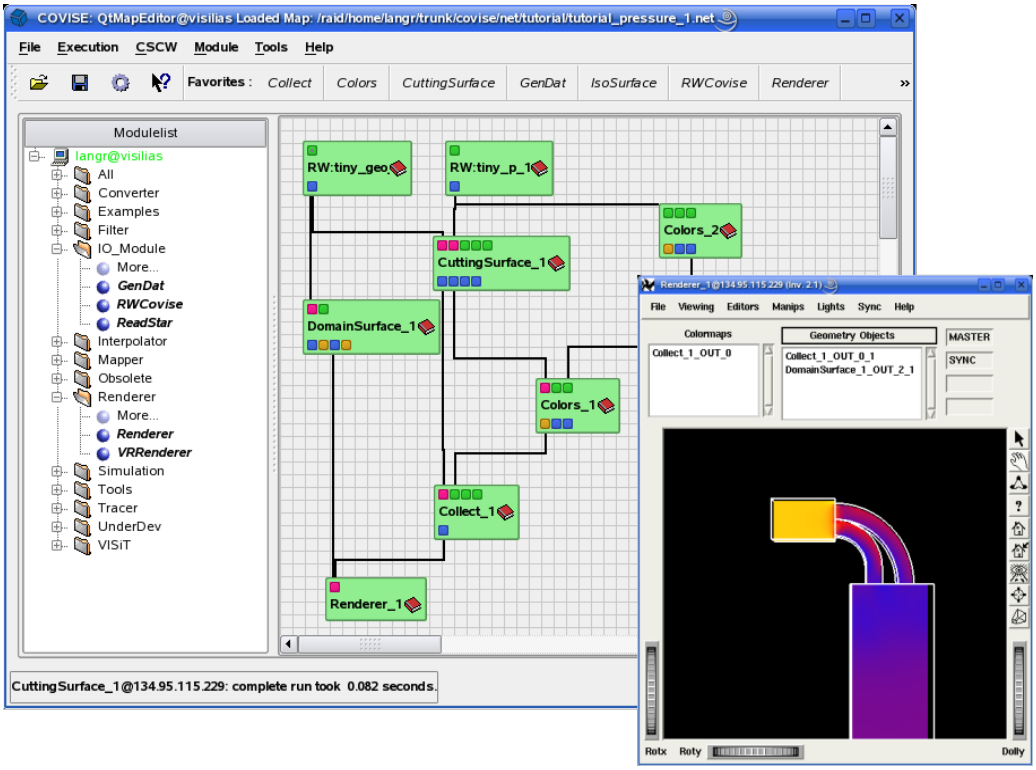


Figure 2.1: Map Editorcontaining a tutorial map

The windows layout consists of the following main parts:

1. the **Menubar** (section 2.1)
2. the **Toolbar** (section 2.3)
3. the **Visual Programming Area** (section 2.5)which is used to show and edit a module network.
4. the **Data Object Browser** (section 2.8)which contains a list of all available modules on a certain host sorted by categories.
5. the statusline which shows the number of existing messages from the **Controller**, modules and other **COVISE** parts and the last content.
6. the **Chat Line** (section 2.12)which is only visible in collaborative working mode

2.1 Menubar

The **Menubar** contains all items to

- manage a **COVISE** session,
- execute dataflow networks (module maps),
- work in collaborative or distributed mode (More details in chapter 5),
- get help information.

2.1.1 File Menu

Most of the items in the *File* entry of the **Menubar** are also avaible in the **Toolbar** (section 2.3):

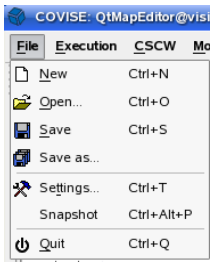


Figure 2.2: File Menu

- **New**

  allows you to generate new module networks from scratch. The whole canvas will be cleared, also the parameters in the **Control Panel** (section 2.7) and all data objects are destroyed. Added hosts will remain in the session.

- **Open...**

  enables **COVISE** to load a previously stored module network including the stored parameter settings. The current layout in the canvas is destroyed as if *New* would have been chosen. If modules are distributed and the used hosts have not yet been included in the session, the passwords for the participating hosts are required.

  The loaded network appears in the **Visual Programming Area** (section 2.5). Each module is represented by an icon. A **Module Icon** (section 2.5.1)consists of input data ports on the top, output data ports on the bottom, a label and a book icon.

- **Save**

  stores the current network and its parameters. This is possible at any time, even while working in collaborative mode. If a previously opened module network exists the same filename and path is used for storing. Otherwise a file browser is opened.

- **Save As...**

  stores the current map and its parameters. A prompt appears asking for a storing location.

- **Settings...**

  defines the layout and behaviour of the **Map Editor**. The parameters are described in **Settings** (section 2.10).

- **Reset Layout**

  resets the default layout.

- **SnapShot**

  copies the content of the **Visual Programming Area** (section 2.5) into a *png file*. If a network is open or has been previously saved the current network is stored using this filename and path. Otherwise the current working directory is used.

- **Quit**

  pops up an logout window (see Fig.2.3) when something was modified. When Yes is selected the **COVISE** session is closed. All participating processes on all attending hosts are also terminated.

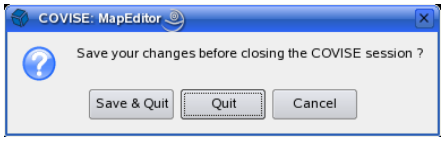


Figure 2.3: Quit COVISE

2.1.2 Execution Menu

When executing a module network one module icon after the other shows a colored frame which indicated that it operates. A module network can be executed once or repeatedly.

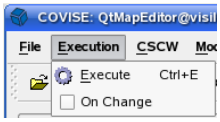


Figure 2.4: Execution Menu

The settings are:

- **Execute**

  the complete module network independent of the previous state. Stored parameter changes are applied. This item is also avaible in the **Toolbar** (section 2.3).

  Executing the module network beginning with a certain module is described in the **Module Actions** (section 2.5.2), **Module Parameter** (section 2.6) and **Control Panel** (section 2.7).

- **OnChange**

  behaves as an update. It initiates an execution after every single parameter change. The **Control Panel** (section 2.7) interactor *Player* and *Sequencer* in play or reverse mode (not in single step) will automatically set *OnChange* and start the execution of the map repeatedly until their ending condition is met. You can also set *OnChange* explicitly within the **Control Panel** (section 2.7).

2.1.3 CSCW Menu

More detailes about distributed and collaborative working mode can be foundin chapter 5.

Additional hosts can be introduced at nearly every time during a **COVISE** session. It serves to use specific resources like supercomputers or fileservers. The first three items of this menu entry are also available in the **Toolbar** (section 2.3).

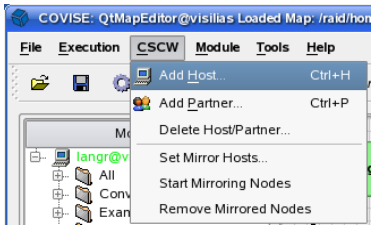


Figure 2.5: Host Menu

- **Request Master State**

  A master/slave relationship is applied among participating partners of a session. This means, that at every point in time only one participant has control over the overall session, while the others can only watch ongoing actions performed by the master. All slave windows are insensitive for user input that influence the network consistency and parameters. Important events are spread to all slaves. Therefore when a new network is generated or edited, every module icon and connection line between module ports also appears on the slave **Map Editor** canvas. The modifications in the **Module Parameter** (section 2.6) and attached parameters in the **Control Panel** (section 2.7) are also spread to the slave sides.

  Clicking on the *RequestMasterState* item pops up an inquiry dialog on the master side, informing that a user on a slave host wants to become the master.

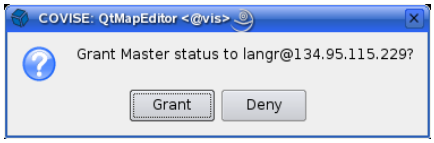


Figure 2.6: MasterRequest Window

  If the master rejects the action the requesting slave will be informed.

  Otherwise the master/slave relationship between these two will be exchanged. As a result the greyed menus of the **MapEditor** on the previously slave side are now in black, while all menu items on the previous master side except for the MasterRequest and the Help button are now in grey.

- **AddHost (Distributed Working)**

  This item adds another host to the current session. No other **Map Editor** or **COVISE** session will be started at that host. Only modules can be executed on this host.

- **AddPartner (Collaborative Working)**

  This item will invite a partner to participate in a current session. A complete **COVISE** session starts on that host. The partner gets an own **Map Editor**. The content of the local windows are duplicated to those windows. By default the invited partner is in a slave state, so he can't initiate actions, until the master/slave relationship is changed via the item *Request Master State* . All important events are spread to all slave user interfaces and all parameters and user actions are copied. The only enabled button in the **Menubar** (section 2.1) of the partner is the *RequestMasterState* and the *Help* button.

  A host in the **Module Browser** (section 2.4) can be deleted by clicking on it with the right mouse button. This action is not possible for the first host of a **COVISE** session.

  Pressing *AddHost* or *AddPartner* will pop up the left window in Fig.2.7. In this window a existing can be selected or typed. The hostnames in the list are the same as in the scope *HostConfig* of

the **COVISE** configuration file. When `OK` is pressed **COVISE** will look for information about the requested host. This is shown in the right window. The default values for the remote host are also taken from the scope *HostConfig* of the configuration file.

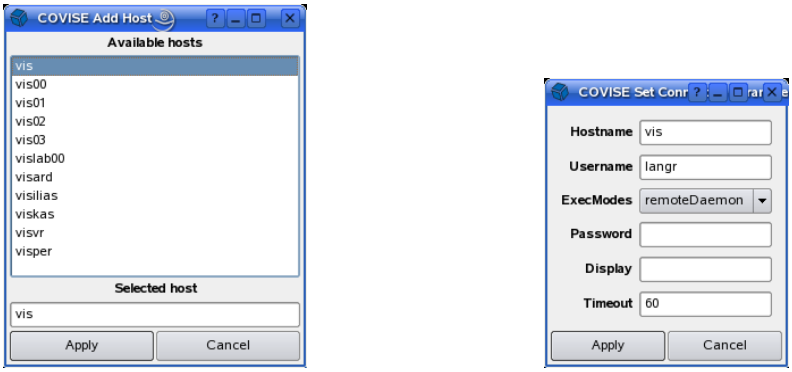


Figure 2.7: Adding hosts for distributed or dollaborative working mode

The timeout value specifies how many seconds a process will wait to be contacted by a new process it initiated (e.g the Controller waiting for module). This parameter should be increased if the network is slow.

The execeution mode specifies the command which should be used to start the **CRB** on the remote computer. Possible execution modes are:

- **rexec**

  An userid and a password for the remote machine has to be typed. This is similar to login on a remote computer via telnet.

- **rsh**

  In this case only the userid is required. A password on the remote machine is not needed. The rsh specific rules for remote execution pf proceses have to be followed.

- **ssh**

  Same as above, but a secure shell is needed.

- **nqs**

  This is not recommended. It can be used to put the **CRB** into a batch queue.

- **manual**

  Manual means that someone has to start the **CRB** process manually on the remote machine. This can be useful for sessions across firewalls or access to the remote account is not available. In this mode **COVISE** writes a message in the window
  `start "crb 31005 129.69.29.12 1005" on visper.hlrs.de` .
  The collaborativg partner has to type in this quoted string.

- **remoteDamon**

  A remote **COVISE** daemon has to run on the other machine. Currently this is only avalaible for Windows.

When the remote host is successfully added, the remote username and hostname will appear in the ist of hostnames of the **Module Browser** (section 2.4) with a different color.

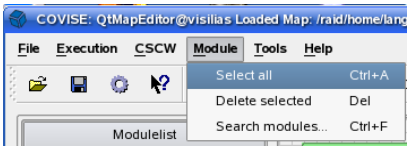


Figure 2.8: Module Menu

2.1.4 Module Menu

Module icons in the **Visual Programming Area** (section 2.5) can be manipulated.

The settings are:

- **Select all**

  All modules in the canvas are selected. Further operations can be applied on this group.

- **Delete selected**

  Delete currently selected modules.

- **Search modules...**

  This entry opens a window which allows to enter a search string. All categories and/or modules containing this string in the name will be highlighted. Icons of these module in the **Visual Programming Area** (section 2.5) will also be highlighted.

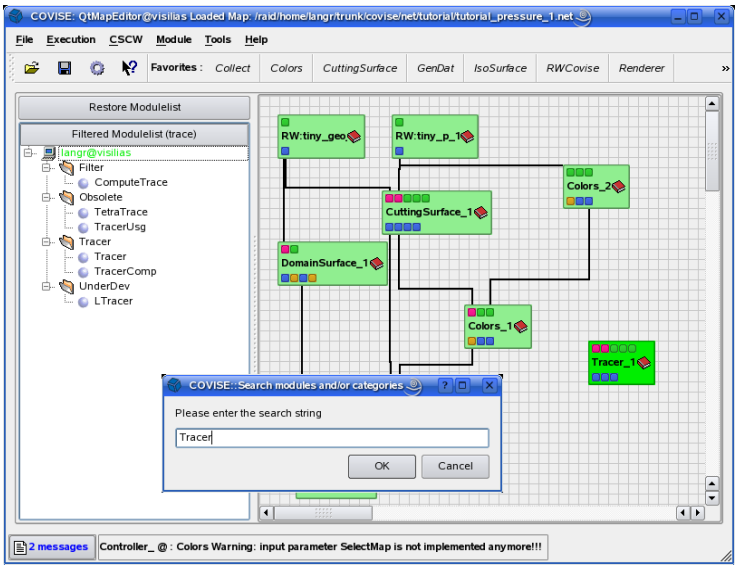


Figure 2.9: List of categories/modules after search operation

2.1.5 Tools Menu

The items of this menu entry open additional window parts.

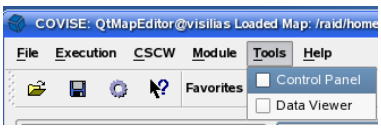


Figure 2.10: Tools Menu

The settings are:

- **Control Panel**

  Enables/disables an additional window on the right side.

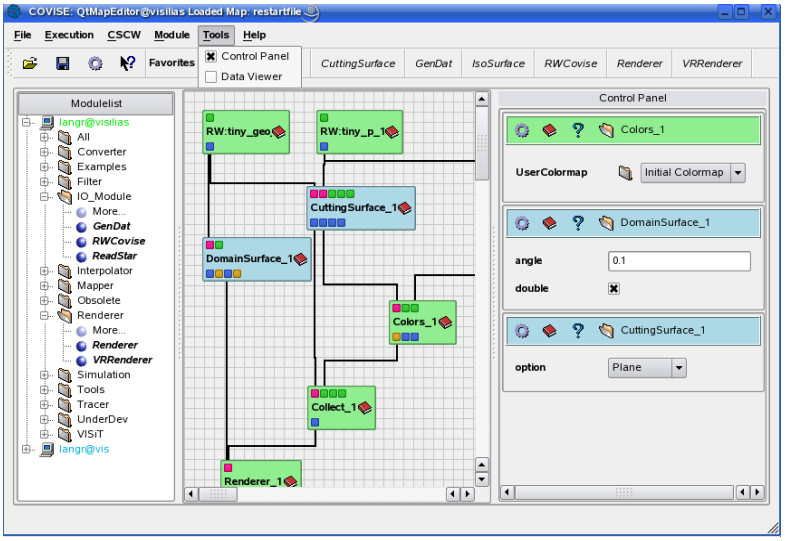


Figure 2.11: Map Editorwith Control Panel

  More information about the **Control Panel** is available in section 2.7.

- **Data Viewer**

  Opens an additonal window containing the **COVISE Data Viewer** (section 2.8) .

2.2 Available Help

2.2.1 Tooltips

A tooltip is a small piece of text that appears when the cursor is hover a widget for a certain period of time. Tooltips are available for all icons of the **Toolbar** (section 2.3), the main buttons in the **Module Parameter** (section 2.6) window, the **Control Panel** (section 2.7), the **Settings** (section 2.10) and some other relevant items.

2.2.2 What's this ?

If more information is needed about a certain region of the **Map Editor** the "What's This ?" mode is ideal. The mode can be entered when the ? icon in the **Toolbar** (section 2.3) is clicked. The cursor changes to *** . Click a region to obtain more information.

2.2.3 Online help

COVISE opens a seperate help window when the item "Help" in the menubar is pressed. This window is also available with `Shift+F1`.

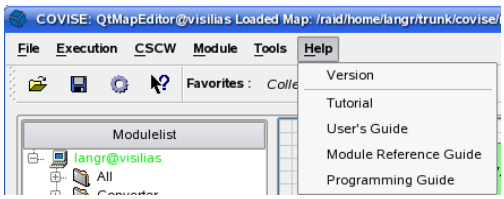


Figure 2.12: Available help items in the menubar

The following help topics are available.

- **Version** shows the version of your **COVISE** installation.
- **Tutorial** opens the online version of the Tutorial
- **User Guide** opens the online version of the User Guide
- **Module Reference Guide** opens the online version of the Module Reference Guide
- **Programming Guide** opens the online version of the Programming Guide

2.3 Toolbar

The **Toolbar** contains

1. icons for the most important actions
2. frequently used modules

2.3.1 Toolbar Icons

or

Figure 2.13: Available icons in the toolbar

These icons have the same behaviour as the items in the **Menubar** (section 2.1). The toolbar is dockable that means it can be disconnect from the main window and show the content in an own separate window. A short decription of the icons is given in the following list:

1. Load a new map into **COVISE**

2. Save the current map. Overrides a given map name !!
3. Execute the module network
4. The "What's This" help cursor
5. Request the master state (only enabled if you are in slave mode)

2.3.2 Favourites

Favourites are often used modules. They can be used in the same manner as modules listed in the **Module Browser** (section 2.4).

Figure 2.14: Frequently used modules

1. The module name can be dragged into the **Visual Programming Area** (section 2.5).
2. New favourite can be addeed to the list by dragging a module from the **Module Browser** (section 2.4) to the favourite list. The drop point marks the position in the list.
3. A favourite can be removed from the list by dragging a favourite name to the **Module Browser** (section 2.4) window.
4. The list can be sorted by double clicking on a favourite name.

2.4 Module Browser

This area contains a hierarchy (tree) displaying the hostnames, category names and module names. When **COVISE** is started in single user mode only the name of the local host is shown in the tree.

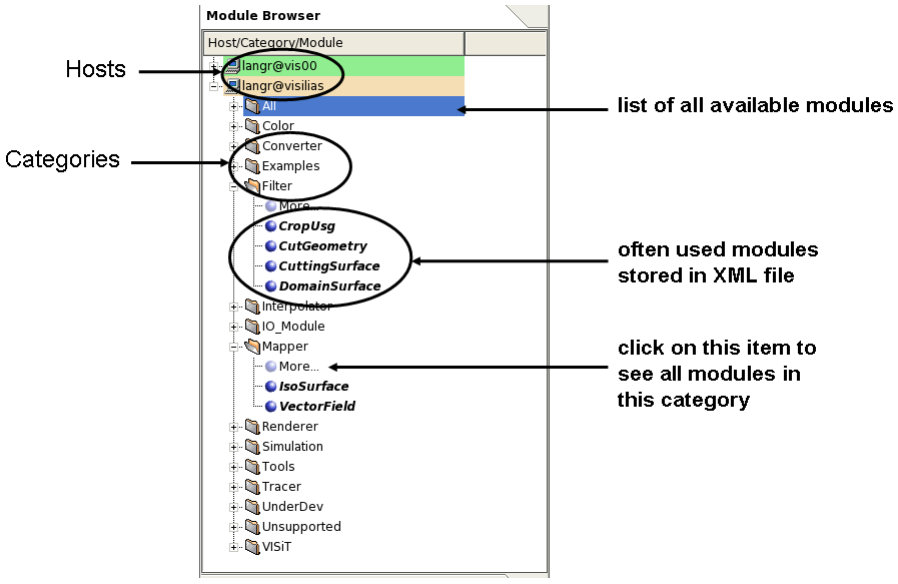


Figure 2.15: Parts of the Module Browser

Modules running on a host appear in the same color as the host name in the list. The subdirectories of `~/covise/ARCHSUFFIX/bin` will be used as names of the categories. The files in each category subdirectory are displayed as module names.

Short description of the category and the modules are shown as tooltips. Clicking on a host with the right mouse button opens a popup menu with one single entry *Delete Host*. Clicking on this item with the left mouse button will remove all modules running on that host and a possible remote user interface. Clicking on a category or module with the right mouse button will open the **COVISE** help system.

The modules shown for each category depend on the choosen modules in former sessions. To simplify the view only modules which have been used before are shown. All other modules are hidden behind the item *More...* Clicking on this item will show all available modules in this category.

The special category *All* contains all available modules in alphabetic order and the corresponding category.

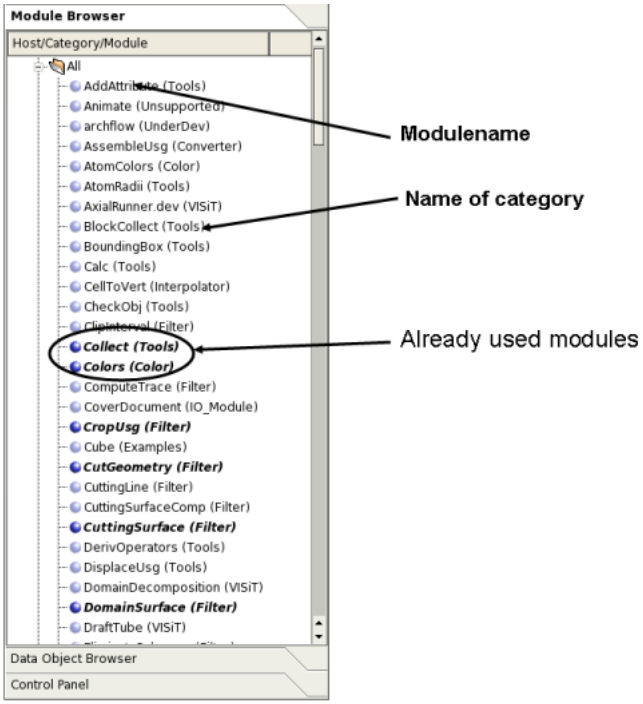


Figure 2.16: The catgory ALL

Interacting with the Module Browser is done in the following ways:

1. Clicking on the +/- sign open/close the corresponding category.
2. Double clicking on a category name opens this specific category and closes all others.
3. Clicking into the **Visual Programming Area** (section 2.5) and typing / allows to enter a search string. All categories containing this string in the module name will be highlighted. Icons of these module in the **Visual Programming Area** (section 2.5) will also be highlighted.

To start a module its module name has to be dragged to the canvas. A **Module Icon** (section 2.5.1) on the canvas indicates, that the respective program representing the module has been started and waits for its execution.

2.5 Visual Programming Area (Canvas)

This canvas is used to show the module network. Module icons, that can be moves around, and connection lines between module ports can be seen. Executing a map visualizes the data using the **Renderer** window. The execution of modules is indicated by highlighting the icon boundaries of currently executing modules. This red highlighting sweeps sequential through the processing pipeline.

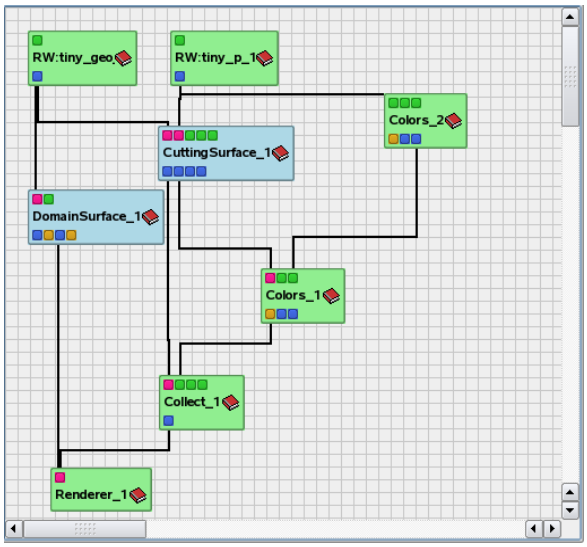


Figure 2.17: The Visual Programming Area

2.5.1 Module Icon

Fig. 2.18 shows a typically module icon. Each module is represented by such an icon. A module icon has

- a background color which corresponds to the hostname color of the **Module Browser** (section 2.4).
- input data ports
  - **pink**
    These ports have to be connected. Otherwise an error message appears.
  - **green**
    These ports can be optionally connected.
- Output data ports
  - **blue**
    Normal output ports
  - **orange**
    These output ports depend on an input port. If such an output port is selected the corresponding input ports change its color and become required. If disconnected the corresponding input port become green again.
- a text label which consists of the module name and an instance number.

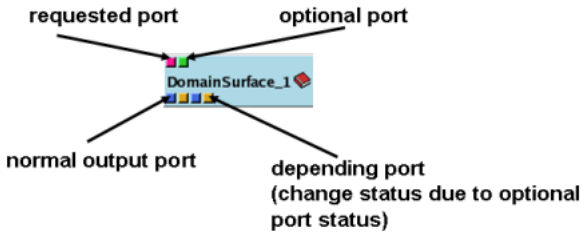


Figure 2.18: Module Icon

- a book icon. If the closed book icon is selected, the **Module Parameter** (section 2.6) window of this module will be opened. In this window the module parameters are shown and can be changed. If an opened book icon is selected, the **Module Parameter** window will be closed.

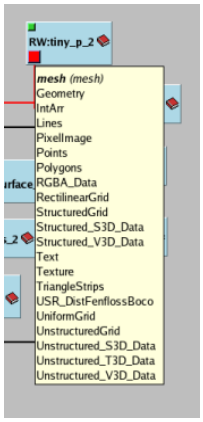


Figure 2.19: Available data types on a port

A tooltip shows port information like name, description and available datatypes. If a data object exists (after the pipline has already been executed) information about the created data type are shown, otherwise the text *No data object* appears.

2.5.2 Module Actions

A popup menu is shown, when the right mouse button is pressed on a module icon. This allows to perform the following module actions:

- **Execute**

  This executes the module network starting from the current module. It is typically more efficient to execute only a part of the map after having changed some parameters instead of executing the whole network. I/O modules often need a lot of time to read in large data files which is not necessary if a module parameter has been modified further down in the module chain.

- **Delete**

  The module is deleted and disappears from the canvas. This function is also avaibale to remove a module group.

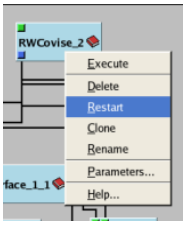


Figure 2.20: Available Module Actions

- **Restart/Move**

  Restarts the module with the current parameter values and connection lines.

  In distributed and collaborative working mode the module is moved to an other host for execution. This means that the module is deleted on the current host and initialized on the other host. The current parameter and connections are moves too. This is only possible, if a further host was added.

- **Clone/Copy**

  An exact copy of the module with the current parameter values is created. Connection lines inside a copied module group are also picked.

  In distributed and collaborative working mode the module is copied to another host for execution. This means that the module is initialized on the other host and remain on the original host. This is only possible, if an additional host was added.

- **Rename**

  The module is renamed. A new name is prompted for. This action is also avilable to add a label to a module group.

- **Parameters**

  The **Module Parameter** (section 2.6)window is opened. This action has the same effect as clicking on a module book icon.

- **Help**

  A HTML module description is shown in the Qt Help viewer, that is part of the **Map Editor**.

2.5.3 How to move a module

Hold down the left mouse button on the module icon. The mouse pointer changes and you can move the icon to a new position. The icon will follow the mouse pointer. Then release the mouse button. If the icons have connection lines to other ports, these lines will be repositioned too.

2.5.4 How to group modules

YThere are two methods for grouping module icons on the canvas:

1. **Specific Selection**

   Press the SHIFT-Key and click on a module icon. The icon background changes to the highlight color (see section 2.10). Doing the same action on an already selected module icon deselects it.

2. **Selection via a rubberband**

   Click on an empty part of the canvas to determine the startpoint of the rubberband rectangle. Keep the mouse button pressed and move the mouse so that module icons which should be

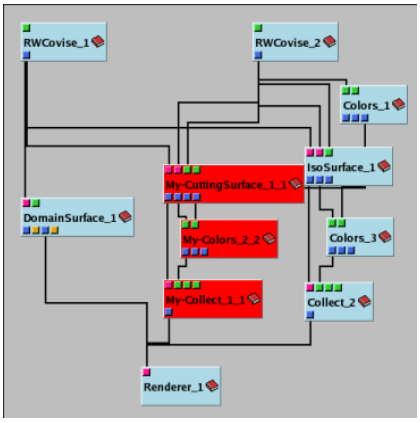


Figure 2.21: Grouped module icons

grouped together lie completely inside the rectangle. After the mouse button is released each of the icons inside the group become red (the current hihglight color). Clicking on an empty part of the canvas ungroups the group.

3. **CTRL+A selects all modules on the canvas**.

2.5.5 Connecting Ports

To build a module network you must connect the output ports of modules to the input ports of follow-on modules. Input and output ports of modules are color coded buttons according to the **Module Icon** (section 2.5.1). A blue input port represents a data port, that has to be connected before a proper execution is possible. A green input port represents an optional port that can have a connection. Not all blue output ports need to be connected.

There are two methods for connecting ports:

1. **Using the left mouse button**

   The easiest way to establish proper connections without looking into the detailed descriptions of the module ports is by clicking with the left mouse button on the port of a module. This leads to highlighting and/or blowing up of matching module ports, which offer the appropriate data type.

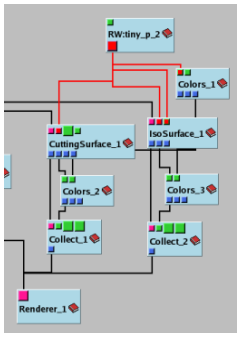


Figure 2.22: Generating a connection line: Image after clicking on a module port

Move the cursor to a heighlighted port. You now see a rubber line following your mouse cursor.

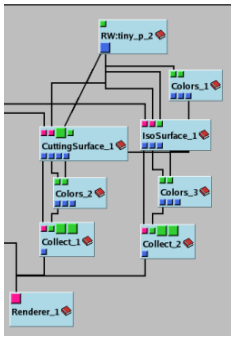


Figure 2.23: Generating a connection line: Move the cursor

The connection is established when the mouse button is released within a port. You can also directly click onto the the desired highlighted port. In the same way you have to connect all modules of a map.

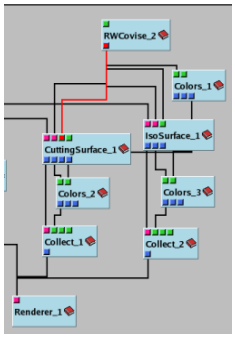


Figure 2.24: Generating a connection line: Connection established

2. **Using the right mouse button**

   Pressing/clicking on a port with the right mouse button pops up a menu that shows matching ports. Selecting an item will create a connection line. This method is best when the network map has a lot a modules some of them outside the visible range.

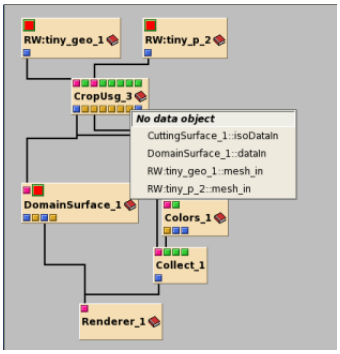


Figure 2.25: Generating a connection line with the right mouse button

Move the mouse over a connection line. The line will be highlighted if the cursor is exactly on the line.

Delete the connection line by a double click or via a popupmenu that is shown when using the right mouse button on a line.

2.6 Module Parameter

Every module can present a detailed view of its input and output data objects as well as its parameters. Click with the left mouse button on the book icon of a module. A new window appears on top of the **MapEditor** window (default) or a new dockable widget becomes visible inside the main **Map Editor** window. The positions depends on your **Settings** (section 2.10) parameter.

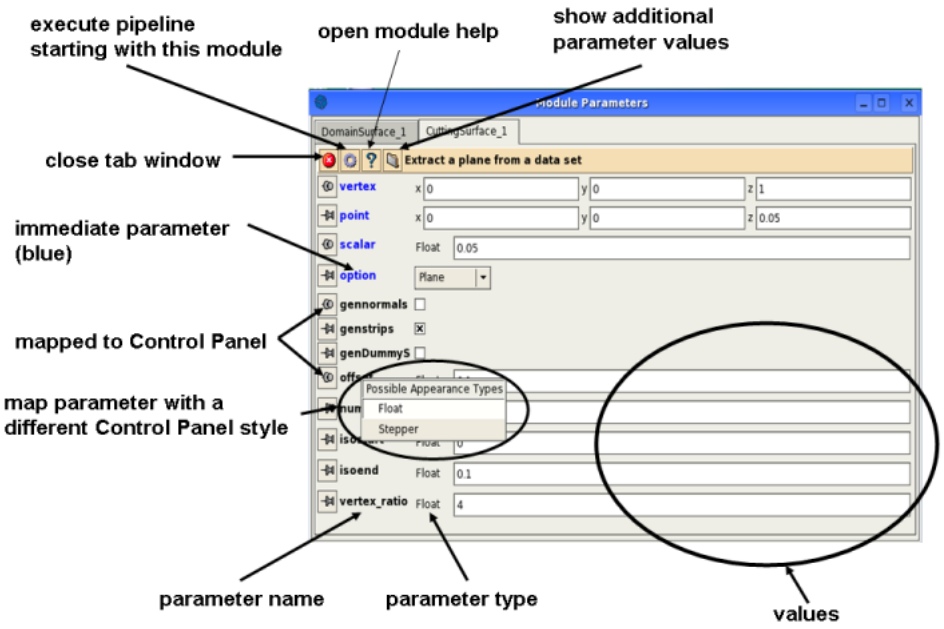


Figure 2.26: Module Parameter Window

Each parameter is represented by

- **Name**

  This toggle button is used to map an interactor to the **Control Panel** (section 2.7) window. It contains also the name of the parameter. The type (*String*, *Boolean*, *Vector*, *Scalar*, *Slider*, *Choice*, *Browser*) and the description is shown as tooltip. Most of the parameters were mapped with a standard appeareance that cannot be changed.

- **Appearance**

  Different appearance types for the parameter can be used *Scalar* and *Slider*. It is always possible to change the type.

  For the parameter type *Brower* and *Colormap* a folder icon is visible. Clicking on this icon opens an additional browser window either below the parameter list inside the **Module Parameter** window or in a seperate window. Clicking on the open file icon will close the browser window.

- **Values**

The value fields contain the parameter values. Depending on the parameter type different input fields to change the values are available. Values can be selectively overwritten . The following list will show the different represenation of the parameter types

String Just type in a string in a text input field.

Boolean A toggle button is shown. Click on it to set/unset the state.

Vector For each element of the vector a short text field is given which is used as a string input field

Choice A combo box with the current item is shown. Click on the arrow to see all items.

Scalar There are integer and float scalar parameters available. In the parameter window both are handled in the same way. There are a text input field for the current value and one for a delta value. The last value is only estimated. Please adapt this value. It is used by the interactors to calculate a new current value.

Slider Slider parameters are values that have a minimum and a maximum value, to be used to step up and down endless as a scalar parameter. They also have a delta value assigned that is used by the interactors.

Browser To choose a filename together with the proper path use either a string input field or a filebrowser. The first alternative is useful if the path and the filename is already known, otherwise open the file browser to find the file. Depending on the settings the file browser is opened in a seperate top level window or inside the **Module Parameter** window.

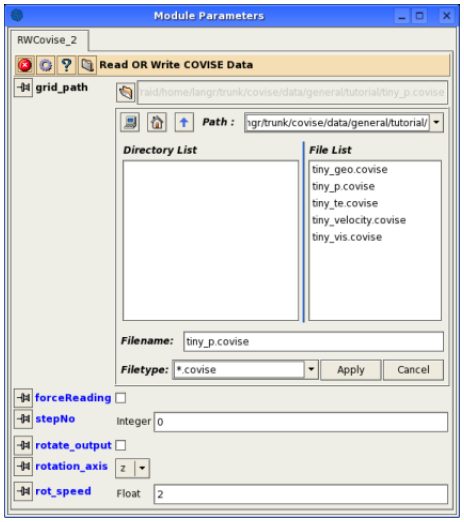


Figure 2.27: File Browser inside the Module Parameter window

Colormap How to modify a colormap is explained in **Colormap Editor** (section 2.9).

2.7 Control Panel

The purpose of the **Control Panel** is the collection of graphical interactors which typically represent often used and changed parameters.

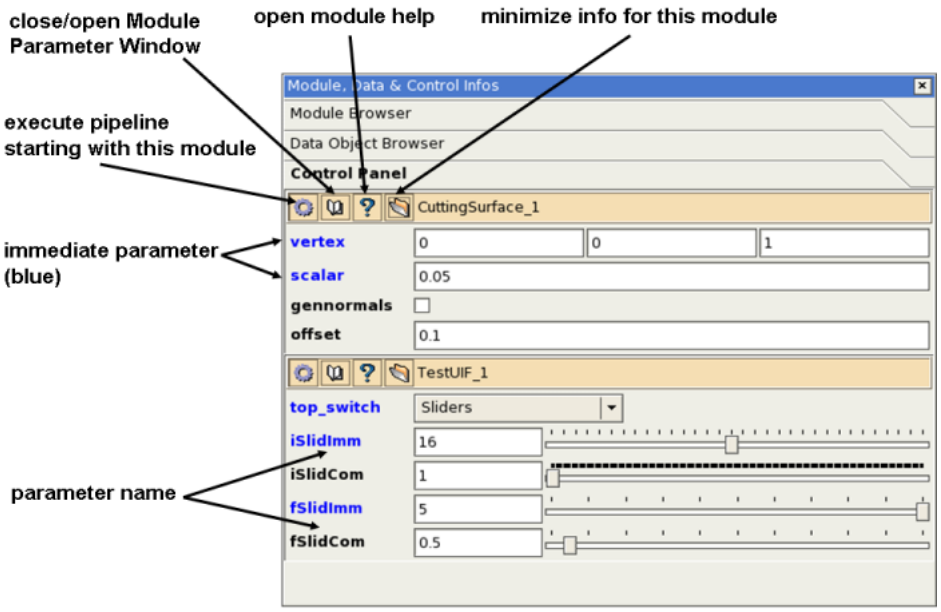


Figure 2.28: Control Panel Window

Widgets corresponding to the parameter types are used for the layout of interactor. Interactors in the **ControlPanel** allow the manipulation of parameters at every time without the need to pop up the **Module Parameter** (section 2.6). By clicking the toggle button in the **Module Parameter** window an interactor is generated. Its representation then appears in the **Control Panel**.

Changes made via interactors in the **Control Panel** (section 2.7) are updated in the corresponding parameter value fields of the **Module Parameter** (section 2.6) window. This works also vice versa.

Available interactors for each parameter are shown in the following list.

- **String** Only one string interactor is available. Just type in a string in a text input field.
- **Boolean** A boolean interactor is realized as a toggle button. Click on it to set/unset the state. This is the only one.
- **Vector** A vector interactor has the same text input fields as in the **Module Parameter** (section 2.6) window. This is the default.
- **Choice** As in the **Module Parameter** (section 2.6) window you see a combo box.
- **Scalar**
  - **Scalar interactor = default** This interactor has the same input fields as in the **Module Parameter** window.
  - **Sequencer interactor** Use this interactor like the control element of a videoplayer. There are no limits for the upper and lower value.

- **Slider**
  - **Slider interactor = default**
  - **Player interactor** Use this interactor like the control elements of a videoplayer. Keep in mind that the value has a range.
- **Colormap** This interactor works the same way as in the **Module Parameter** (section 2.6) window. Open/close a filebrowser if necessary.
- **Browser** This interactor works the same way as in the **Module Parameter** (section 2.6) window. Ppen/close a filebrowser if necessary.

2.8 Data Objects, Data Viewer

Data objects are created when a map is executed. The names of the data objects are generated generically, after the map was executed once. After a new execution the list is updated with the new names.

If you select a data object in the **Data Object Browser** more information is shown in the **Data Viewer** (section 2.8) on the right side of the **Map Editor**

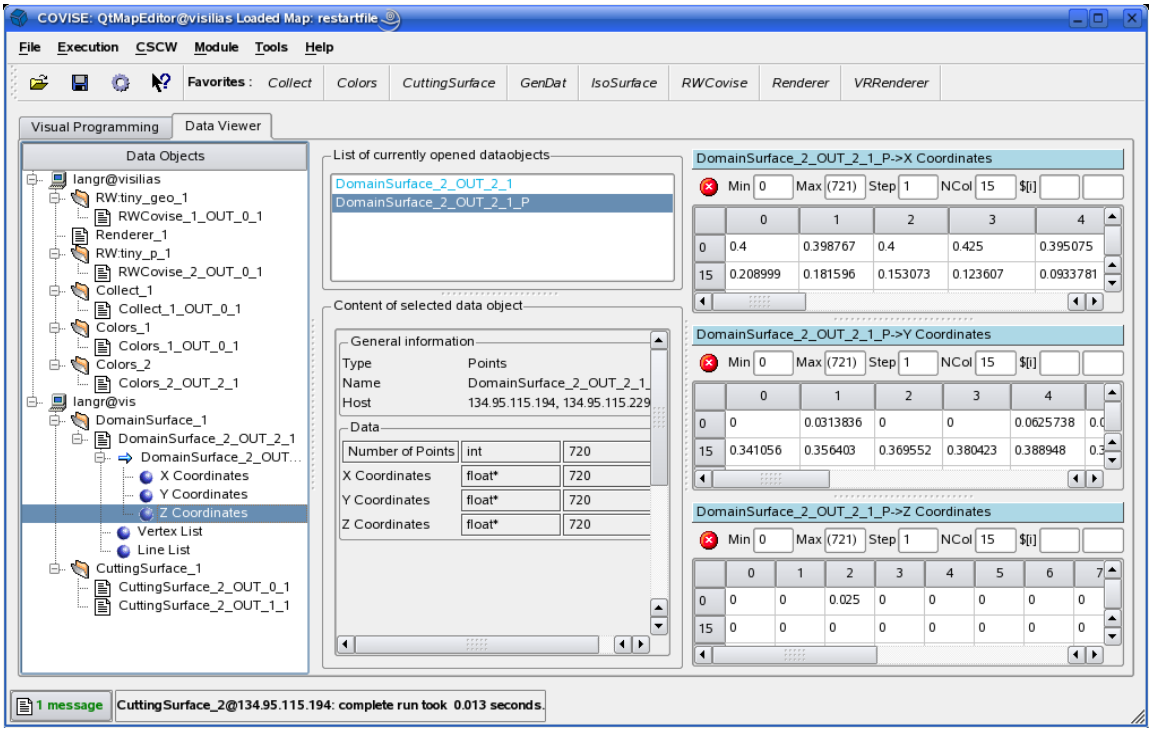


Figure 2.29: Explore a COVISE Data Objects

Be careful if the data field is large or the data is located on another host, because this action will be time consuming.

2.9 Colormap Editor

The purpose of the colormap editor is to define the "transfer function", i. e. the mapping from scalar values to opacity (i. e. inverse transparency) and colour values. The range of your data is mapped to

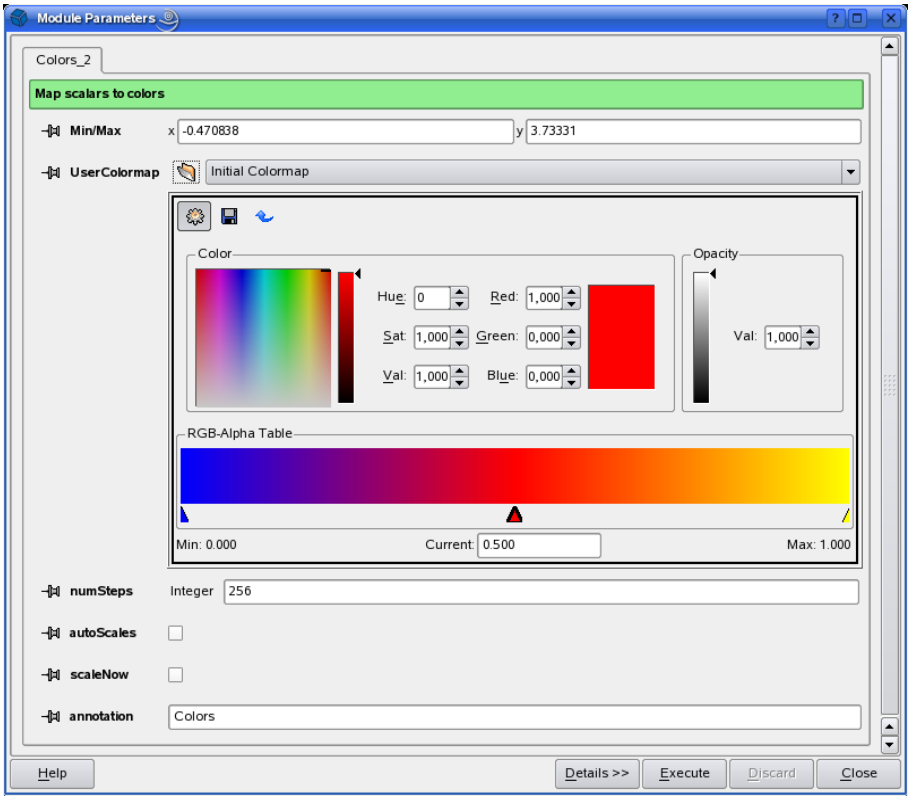


Figure 2.30: The Colormap Editor

$[0, 1]$ for the purpose of defining colour mappings.

The transfer function is given as a piecewise linear mapping, the small triangles ("interpolation markers") below the coloured bar in the picture above serve as nodes for linear interpolation. By clicking on an interpolation marker you can select it for manipulation:

- change its position by dragging it or by entering a new value in the input field labelled "Current",
- modify colour and opacity – this is described in more detail below.

The opacity can be modified by the self-named slider and input fields. For changing the colour values, there are more possibilities:

- enter red/green/blue values (in the range from 0 to 1) in the corresponding input fields,
- modify the colour according to the hue/saturation/value space: choose a colour hue and saturation in the large square and select the value in the coloured slider to the left of the large rectangular region, where the current colour is displayed,
- specify numerically hue, saturation and value in the corresponding input fields.

The resulting colour map is displayed in the large bar near the bottom.

For speeding up, chose from predefined colour maps available in the configuration file with the "Available Colormaps" combo box, use the button labelled "Save in ConfigFile" for adding such a colour map.

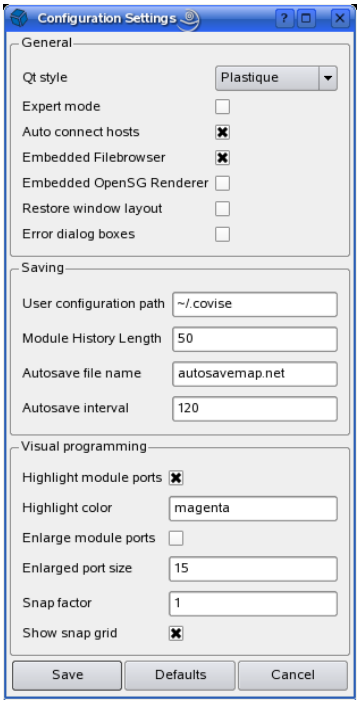


Figure 2.31: Settings for the Map Editor

2.10 Settings

Settings are used for the appearance and behaviour of the **Map Editor**. These parameters are stored in the file *mapqt.xml* which resides in `$HOME/.covise` and in `$APPDATA\covise` respectively.

- **QT style (default)**

  defines the Qt theme used for the layout. These themes can differ from one operating system to the other. On Linux systems the default style is used.

- **Expert Mode (off)**

  If set all modules in the **Module Browser** (section 2.4) are always shown.

- **Auto connect hosts (on)**

  Autoconnect hosts of a loaded network if this map contains additional hosts.

- **Embedded Filebrowser (on)**

  Opens the filebrowser for this module parameter inside the **Module Parameter** (section 2.6) window.

- **Embedded OpenSG Renderer (off)**

  Integrate the OpenSG renderer windows inside the **Map Editor** as a tab on the right side. Currently not implemented.

- **Restore window layout (on)**

  After quitting the **Map Editor** all positions and sizes of all windows are stored and reopened again the next time.

- **Error dialog boxes (off)**

  Off - show errors in the **Message Area** (section 2.11).
  On - pops up a dialog error window.

- **User configuration path (/.covise)**

  Path for storing files.

- **Module History Length (50)**

  Maximal numbesr of modules that will be stored.

- **Autosave file name (autosavemap.net)**

  After a certain amount of time a map is automatically stored using the above name.

- **Autosave interval (120)**

  After a certain amount of time (120 sec) a map is automatically stored.

- **Highlight module ports (on)**

  When connecting ports in the **Visual Programming Area** (section 2.5) highlight matching ports.

- **Highlight color (red)**

  Color name (from rgb.txt) for highlighting ports, connection lines and module icons.

- **Enlarge module ports (on)**

  When connecting ports in the **Visual Programming Area** (section 2.5) blow up module ports for better visibility .

- **Enlarged port size (15)**

  Hight of enlarged module ports in pixel.

- **Axis aligned connections (off)**

  When moving module icons in the **Visual Programming Area** (section 2.5) the move of corresponding connection lines were shown (time comsuming)

2.11 Message Area

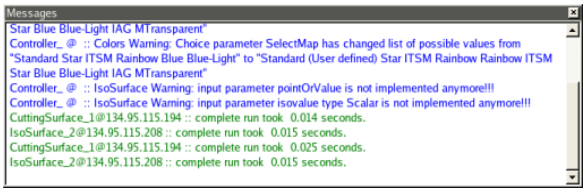

Messages
Star Blue Blue-Light IAG MTransparent"
Controller_ @ :: Colors Warning: Choice parameter SelectMap has changed list of possible values from
"Standard Star ITSM Rainbow Blue Blue-Light" to "Standard (User defined) Star ITSM Rainbow Rainbow ITSM
Star Blue Blue-Light IAG MTransparent"
Controller_ @ :: IsoSurface Warning: input parameter pointOrValue is not implemented anymore!!!
Controller_ @ :: IsoSurface Warning: input parameter isovalue type Scalar is not implemented anymore!!!
CuttingSurface_1@134.95.115.194 :: complete run took 0.014 seconds.
IsoSurface_2@134.95.115.208 :: complete run took 0.015 seconds.
CuttingSurface_1@134.95.115.194 :: complete run took 0.025 seconds.
IsoSurface_2@134.95.115.208 :: complete run took 0.015 seconds.

Figure 2.32: Message Area

This scrollable text output window shows messages with different colors

- Error message are colored red.
- Warning message are colored blue.
- Info message are colored green.
- Informations and control output produced by the **Map Editor** itself are black.

Messages are sent from modules during their execution, the **Controller** and the request broker **CRB**.

2.12 Chat Line

This editable text field is used for sending information to other partners joining a **COVISE** session. As expected, the chat line is shown for two or more partners only.

3 COVER

COVER (COvise Virtual Environment Renderer) is a COVISE renderer module with support for Virtual Reality (VR) input devices, backprojection displays, and intuitive interaction. COVER can also be started independendly of COVISE and just be used as a virtual reality viewer for 3D geometry.

To start COVER within COVISE, select the module COVER in the module list under the category Renderer.

To start COVER as a 3D viewer, type in

```
cover <filename>
```

Note: Please make sure to set the variable DISPLAY in your environment before starting COVER!

COVER is based on Performer, a high level 3D graphics library from SGI, providing high speed rendering, multi-processing, multi-pipe, scene graph, loaders for 3D database formats... Performer is available for IRIX and Linux platforms.

This chapter about COVER describes the **COVER User Interface** and has the two sections:

- **Interaction in COVER** (3.1): This section describes how to use COVER. It explains the entries in the 3D menu and the corresponding interaction techniques.
- **PlugIns** (3.2): This section describes the plugins "Probe" and "Viewpoints".

For configuration of displays and input devices see the separate document

COVER Installation and Configuration

with the sections

- **Graphics Board and Display**: This section explains which types of Virtual Environments are supported and how to configure COVER and your graphics workstation for this Virtual Environment.
- **Input Devices**: This section explains which types of Virtual Environments are supported and how to configure COVER and your graphics workstation for this Virtual Environment.

3.1 Interaction

COVER can be used either as a viewer for 3D scenes or as a renderer module in COVISE.

As a 3D viewer COVER supports all 3D file formats which are also supported by the graphics library OpenGL Performer and additionally vrml files with sound and interaction. To load a specific file call COVER with the file name as parameter:

```
cover <filename>
```

As a COVISE renderer module COVER is started through the Mapditor. Select the category renderer and drag the module COVER to the map area. You can now connect all modules to COVER which

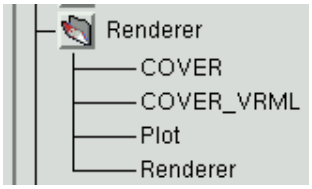


Figure 3.1: Starting COVER as COVISE Renderer Module

generate geometric primitives like lines, triangle strips, polygons or points with colors, normals and textures.

If you have a full COVISE installation you will recognize that there are two COVERs: one called COVER and one called COVER_VRML. Only the second one supports vrml files with sound and interaction. As you don't need this functionality for most COVISE visualisations, a smaller version without vrml support, named COVER, is provided, too.

3.1.1 Headtracking and 3D Pointer

In COVER the user can freely move in the virtual scene and manipulate it with a 3D input device.

The movement of the user is measured with a sensor mounted at the glasses. With the measured position and orientation an appropriate view on the scene is computed. This is called head tracking. Currently only one user can be tracked. Other users don't have the correct view of the scene and therefore they have the impression that all objects are slightly distorted. This effect is minimized if they try to stand close to the user with the tracked glasses and try to look into the same direction as the one with the tracked glasses.

The location and orientation of the 3D input device, which the user holds in his hand, is measured through a sensor in the input device. The input device usually has one two three buttons. One button is used to indicate a selection. On a three button device the other two buttons are used to switch the navigation mode without using the 3D menu.

With the virtual laser beam which seems to come out of the 3D input device also remote objects can be reached, for example buttons in the 3D menu.

Using COVER with the mouse

COVER can also be used with the mouse. The viewer position is then fixed to the position defined in covise.config:

```
COVERConfig
{
    ...
    TRACKING_SYSTEM MOUSE
    VIEWER_POSITION  <x> <y> <z>
    ...
}
```

The interaction possibilities with the menu and the 3D scene are described in the following chapters.

3.1.2 Stereo Viewing

For the stereo projection two images are generated, one with the perspective of the right eye and one with the perspective of the left eye. The stereo glasses show only the appropriate image to each eye. Like stereo viewing in reality the brain forms a 3D impression of the scene.

Figure 3.2: Selecting a menu entry with the laser beam

And similar to reality objects which are very close to the users head are seens twice because the two images can't be fused any more, objects which are very far don't appear to be three dimensional but flat. Therefore the optimal location of obejcts for stereo viewing are not too near and not too far.

If the scene size fits into the virtual reality environment, the best position is near the front screen, optimally one part of the scene is in front of the screen and the other part behind. For many technical visualisations for example flow visualisation of the air around a car the scene can be scaled so that it fits into the virtual environment (see chapter xy view all).

Larges scenes like landscapes are best viewed on large screens. If the scene is larger than the screens, but the screen is so small that it is inside the users field of view the stereo impression can get lost, when the object is located in front of the screen. This happens because the human brain is so used to the fact that in reality objects partly covered by something are behind that it can't form a stereo impression if a virtual scene is cut by the frame of the screen. Therefore for large scenes and small screens the best position is behind the screen and the screens is like a window to the outside.

3.1.3 3D Menu

The navigation mode, viewing options, and manipulation modes are selected through a 3D menue, called the Pinboard. You select a menu entry by pointing to the button with the laser beam and pressing the button of the 3D input device. If the pinboard is used with a mouse simply bring the mouse pointer over the menu entry and click a button.

The COVER Pinboard can be re-positioned in the VE by pointing to the title bar and pressing the button of the 3D input device.If you have a 3-button device and select it the left button, the menu is rotated around it's z axis so it always faces the viewer (billboard mode). Selected with the right button, it moves as if it's mouned at the laser beam. Selected with the middle mouse button it changes it's size according to the rotation of the users arm.

The same applies for mouse input: left mouse button moves the menu in a way that it faces the viewer, right mouse button moves the menu with the mouse pointer. The orientation is defined through a line from the viewer to the mouse so it seems to face the viewer, too. Middle mouse button scales the menu, movements up and down make the menu larger and smaller.

For one-button devices the billboard mode and the scaling is not supported.

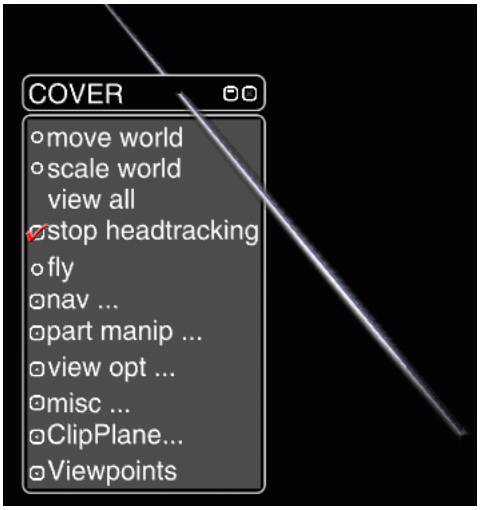


Figure 3.3: Menu Positioning

The initial position, orientation, size, layout of the menu and the start values of toggleand group buttons can be specified in the file covise.config (see configuration in cover installation guide).

Menu Button Types

In the 3D menu there are three different types of buttons.

Simple Buttons with only a label execute a certain function once, for example if you press the "view all" button , the scene is scaled once so that it fits onto the screen.

Toggle buttons switch between two states, for example you can switch headtracking on or off.

Radio buttons select one function in a group of functions. All navigation functions are in such a button group, if you you have "move world" on and then switch to "scale world" the "move world" button is switched off. All collaborative working modes are also in a separate button group. Group buttons can be spread across the menu and the submenus.

Slider buttons

are used to select a numerical value between a minimum and a maximum value. The "drive speed" button is such a slider button. Currently only floating value slider buttons are implemented.

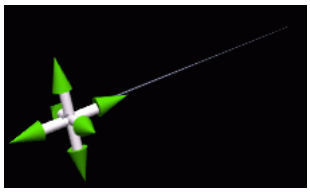
Submenu buttons open a new menu. The submenu can be selected and dragged like the pinboard.

3.1.4 Navigation Modes

With the functions XFORM, SCALE, FLY, DRIVE, WALK the user navigates through the scene. These functions are grouped into a radio button group, therefore only one navigation mode can be active.

Figure 3.4: Submenu Button

Move World (XFORM)

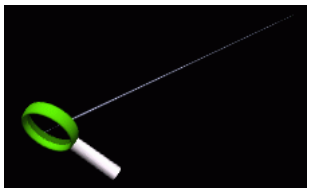


In XFORM mode (XFORM stands for transform) the whole scene (besides the coordinate axis and the pinboard) can be moved. The default button label is "move world" and the default button location is in the main Pinboard menue. The XFORM mode indicated with the above 3D icon.

Only when the button of the 3D input device is pressed, the world is translated and rotated with the users hand. The translation is relative to the point where the button was pressed. The center of rotation is the users hand. The interaction is stopped when the button is released. For pulling the whole scene closer to the user you can move the hand away from the body, then press the button and move the hand closer too th body, and then relase the button. Do this several times if the appropriate position can't be reached in one step.

If the input device is the mouse, the scene is rotated when the left mouse button is pressed and translated when the middle mouse button is pressed. In rotate mode, up/down movements rotate around the x axis, left/right movements rotate around the z axis. In translate mode, up/down movements translate into positive and negative z direction, left/right movements into positive/negative x axis.

Scale World (SCALE)



In SCALE mode the whole scene (besides the coordinate axis and the pinboard) can be scaled. The default button label is "scale world" and the default button location is in the main Pinboard menue. The button belongs to the button group "Navigation". The SCALE mode indicated with a magnifying class as 3D icon.

When the button of the 3D input device is pressed and the hand is moved to he right, the world becomes larger, when the hand is moved to the left, the world becomes smaller. The interaction is stopped when the button is released.

The same applies for mouse input.

View All (VIEW_ALL)

When the VIEW_ALL button is pressed, the whole scene (besides the coordinate axis and the pinboard) is scaled so that it fits into the visible part of the world - typically the screen size. The default button

label is "view all" and the default button location is in the main Pinboard menue. The button is a function button.

The size for the scaling is defined in the file covise.config in the section COVERConfig with the keyword SZENE_SIZE. It is defined in mm. A 19" Monitor for example has 340 x 270 mm, there a good choice would be 270, in a CAVE with the wall size 2800 x 2500 mm we would choose 2500.

```
COVERConfig
{
    ...
    SCENE_SIZE <size in mm>
    ...
}
```

COVER also supports an "autoscale" mode. In this mode a "view all" is performed every time a new object is appended to the scene graph. You enable this mode in the scope COVERConfig with the keyword SCALE_ALL.

```
COVERConfig
{
    ...
    SCALE_ALL <ON or OFF>
    ...
}
```

Stop Headtracking (FREEZE)

With FREEZE headtracking is enabled/disabled. The default button label is "headtracking" and the default button location is in the main Pinboard menue. The button is a toggle button. The default state is OFF, this means headtracking is enabled.

Freezing the current view can be useful for demonstrations with many people, where it is impossible, that all users move with the demonstrator. Or for taking pictures or making a video. There you get the best results when the camera position matches the viewer position. In some configurations the camera must be in the area where the magnetic tracking system doesn't deliver correct values. Then you can freeze headtracking at starting time and specify a viewer position:

```
COVERConfig
{
    ...
    FREEZE ON
    VIEWER_POSITION  0 -3000 500
    ...
}
```

This means for example the viewpoint is 3 m in negative y direction and 50 cm above the origin in z direction. The Performer coordinate system is x=RIGHT, z=UP, and Y=into the screen.

FLY

In FLY mode the whole scene (besides the coordinate axis and the pinboard) is moved as if the user sits in an airplane. The default button label is "fly" and the default button location is in the "Navigation" submenu. The button belongs to the button group "Navigation". The FLY mode indicated with an airplane as 3D icon.

You start the fly mode by pressing the button of the 3D input device and then moving the hand into the direction you want to fly. Moving the hand far away from the point where you pressed the button results in faster flying. Moving the hand close to the body behind the point where you pressed the button, results in flying backwards. A scale factor for the fly speed can be applied with the slider "SPEED".

Mouse input in fly mode doesn't work.

WALK

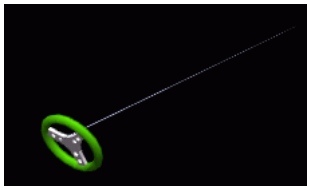
In WALK mode the whole scene (besides the coordinate axis and the pinboard) is moved as if the user walks in the scene. The default button label is "walk" and the default button location is in the "Navigation" submenu. The button belongs to the button group "Navigation". The WALK mode is indicated with shoes as 3D icon.

You start the walk mode by pressing the button of the 3D input device and then moving the hand into the direction you want to walk. COVER then intersects a line from the feet into the negative z direction (towards the bottom) with the scene and if close enough, repositions the user on that point in the scene. As the feet are not tracked, the feet position is calculated from the head position and the floorHeight and the stepSize. FloorHeight and stepSize are specified in the section COVERConfig in the file covise.config.

```
COVERConfig
{
    ...
    floorHeight <z position of the floor in mm>
    stepSize <step length in mm>
    ...
}
```

When using a mouse for input, pressing the left button and moving the mouse up, down, left right moves forward/backward,left and right.

DRIVE



In DRIVE mode the whole scene (besides the coordinate axis and the pinboard) is moved as if the user drives in the scene. The default button label is "drive" and the default button location is in the "Navigation" submenu. The button belongs to the button group "Navigation". The DRIVE mode is indicated with a driving wheel as 3D icon.

COLLIDE

With COLLIDE collision detection between the viewer and the scene is enabled/disabled. The default button label is "collide" and the default button location is in the "Navigation" submenu. The button is a toggle button. The default state is OFF.

SPEED

With SPEED you can adjust a scale factor for the velocity in fly, drive or walk mode. The default button label is "speed" and the default button location is in the "Navigation" submenu. The button is a slider button. The default minimum speed is 1 and the default amximum speed is 30. The default value is 1. The minimum and maximum and the initial value can be defined in the scope COVERConfig:

```
COVERConfig
{
    ...
    SPEED               <min> <max> <initial value>
    ...
}
```

Viewpoints

The "viewpoints" submenu is described in the section about plugins.

3.1.5 View Options

COORD_AXIS

With COORD_AXIS drawing of a coordinate axis system is enabls/disabled. The default button label is "coord axis" and the default button location is in the "view options" submenu. The button is a toggle button. The default state is OFF.

The axis are drawn as lines with a small arrow at the end. The origin is in the world coordinate origin and the length of the axis is 0.5 * SZENE_SIZE. The wolrd coordinate system origin is defined in the scope ScreenConfig (see ection Display Configuration) through the position of the screen center and the orientation of the screen.

Typically the x axis points to the right and is drawn red, the y axis points into the screen and is drawn green and the z axis points up and is drawn in blue.

SPECULAR

With SPECULAR the properties of the light are changed so that objects with a specular material appear specular. The default button label is "specular" and the default button location is in the "view options" submenu. The button is a toggle button. The default state is ON.

SPOTLIGHT

With SPOTLIGHT a lamp like light is attached to the users hand. The default button label is "spotlight" and the default button location is in the "view options" submenu. The button is a toggle button. The default state is OFF.

STEREO_SEP

With STEREO_SEP the offset between the left and right eye can be set to zero. The default button label is "stereo separation" and the default button location is in the "view options" submenu. The button is a toggle button. The default state is OFF.

When STEREO_SEP switched on, only the ofset is set to zero. The video mode is not changed to a mono mode, so you don't have any rendering performance advantage. Use STEREO_SEP for example if you want to take pictures or a video from the VE.

3.1.6 Part Manipulation

SNAP

With SNAP constarints for the manipulation of objects are enabled/disabled. The default button label is "snap" and the default button location is in the "part manipulation" submenu. SNAP is a TOGGLE button. The default state is OFF.

Currently only the cuttingsurface and cutgeometry interaction supports snapping. In CuttingSurface and CutGeometry interaction the plane orientation is corrected to angles which are multiples of 45 degree.

REMOVE

In REMOVE mode objects can be selected with the pointer ray and can removed on button press.

The default button label is "remove" and the default button location is in the "part manipulation" submenu. The button belongs to the button group "Navigation". The REMOVE mode indicated with a red pointer ray.

UNDO

With UNDO the REMOVE actions are undone. The default button label is "undo" and the default button location is in the "part manipulation" submenu. UNDO is a function button. To undo several remove actions, press UNDO several times.

MOVE_PARTS

With MOVE_PARTS a cetrtain object can be selected and re-position/re-oriented. The default button label is "move parts" and the default button location is in the "part manipulation" submenu. The button belongs to the button group "Navigation". In MOVE_PARTS mode the object which is closest to the pointer ray is selected and if the button on the 3D input device is pressed, moved with the hand. The movement is relatively to the position where the button is pressed.

3.1.7 Animation

FORWARD

FORWARD sets the animation mode to forward playing. This means that the objects in the animation sequence are drawn one after each other. After the last object in the sequence it re-starts with the first object. The button appears only if COVER receives a COVISE set objects with timesteps. The default button label is "forward" and the default button location is in the "animation" submenu. FORWARD is a function button.

Backward

BACKWARD sets the animation mode to backward playing. This means that the objects in the animation sequence are drawn in backwards order. After the first object in the sequence it re-starts with the last object. The button appears only if COVER receives a COVISE set objects with timesteps. The default button label is "forward" and the default button location is in the "animation" submenu. FORWARD is a function button.

ANIM_SPEED

With ANIM_SPEED the time interval how long an object in the sequence is drawn, can be set. The default button label is "anim speed" and the default button location is in the "animation" submenu. FORWARD is a slider button. The minimum and maximum value and the initial value can be defind in the scope COVERConfig:

```
COVERConfig
{
    ...
    ANIM_SPEED              <min> <max> <initial value>
    ...
}
```

The default values are min=0, max=5,0 and value=1.0.

When the slider is set to the maximum value, objects are drawn as fast as possible. In this case a timestep containing only a few objects is drawn faster than a timestep containing a large number of objects.

Steady Cam

With STEADY_CAM the user can attach the viewer to an animated object and move with this object. For example if the viewer wants to see a car crash from the view of the person sitting in the car he can attach the camera to the seat and then he is moved with the crashing car. The default button label is "steady cam" and the default button location is in the "animation" submenu. The button belongs to the button group "Navigation".

3.1.8 COVISE

The Mapeditor function "Execute" and the parameters of the most important COVISE modules can be accessed from within COVER.

EXECUTE

With the function button EXECUTE the whole pipeline is eceuted once. The default button label is "execute pipeline" and the default button location is in the "COVISE" submenu.

CUTTINGSURFACE

The module CuttingSurface cuts a plane/cylinder or sphere out of a 3D grid and interpolates the data to the plane/sphere/cylinder. The position and orientation of the cutting surface is specified with the parameters vertex and scalar. In the 2D interface the user has to provide the orientation of the plane with the parameter vertex (which is the normal on the plane) and the parameter scalar (which defines the distance from the origin).

In COVER the user selects the button Cuttingsurface_i, where i stands for the instance of the module. A transparent plane is now attached to the users hand. The plane can be positioned in the scene inside the geometry by moving the hand to the desired position/orientation. When the Select-button of the 3D input device is pressed, the current position/orientation is converted to a normal and distance and sent back to the CuttingSurface module. The CuttingSurface module is automatically executed and within a few seconds the new cuttingsurface appears in COVER.

The default button label is "CuttingSurface i", where i is replaced by the module instance and the default button location is in the "COVISE" submenu. The button belongs to the button group "Navigation", this means that if the previos mode was a navigation mode like XFORM, this mode is switched off.

CUTGEOMETRY

The module CutGeometry cuts a COVISE geometry with a plane. The position and orientation of the cutting plane is specified with the parameters vertex and scalar. In the 2D interface the user has to provide the orientation of the plane with the parameter vertex (which is the normal on the plane) and the parameter scalar (which defines the distance from the origin).

In COVER the user selects the button "CutGeometry i", where i stands for the instance of the module. A transparent plane is now attached to the users hand. The plane can be positioned in the scene inside the geometry by moving the hand to the desired position/orientation. When the Select-button of the 3D input device is pressed, the current position/orientation is converted to a normal and distance in object space and sent back to the CutGeometry module. The CutGeometry module is automatically executed and within a few seconds the new cutted geometry appears in COVER.

The default button label is "CutGeometry i", where i is replaced by the module instance and the default button location is in the "COVISE" submenu. The button belongs to the button group "Navigation".

ISOSURFACEP

The module IsosurfaceP computes an isosurface which contains a certain point. This point is specified with the parameter point. Then the value at this point is computed and the all grid points, containings this value are computed. In the 2D interface the user nters the x, y, and z coordinate of the point in object coordinates.

In COVER the user selects "IsosurafceP i", where i stands for the instance of the module. A red sphere is attached to the users hand. The sphere can be positioned in the scene by moving the hand to the desired point. When the Select-button of the 3D input device is pressed, the current position is converted to a object coordinates and sent back to the IsosurfaceP module. The IsosurfaceP module is automatically executed and within a few seconds the new isosurface appears in COVER.

The default button label is "IsosurfaceP i", where i is replaced by the module instance and the default button location is in the "COVISE" submenu. The button belongs to the button group "Navigation".

Tracer

The COVISE modules TracerUSG, MagTracer, MagBlockTracer, STracer, BlockSTracer, CellTracer and TetraTrace all computes streamlines or particle traces.

The traces start either on a line or on a plane. In the COVISE module the line is specified with the parameters startpoint1 and startpoint2, and the number of traces started on that line is defined with the parameter no_startpoints. The plane is specified with the parameters startpoint1, startpoint2 and normal.

In COVER the user selects "*Trace* i" from the Pinboard, where *Trace* stand for the Tracer module and i for the instance of the module. A red sphere is now attached to the users hand. When the user presses the select-button of the 3D input device, the current position is converted to object space and is taken as startpoint1. The user can move the hand now to the endpoint of the line while keeping the select-button pressed. When he releases the button the current position is converted to object space and is taken as startpoint2. The parameters are sent back to the tracer module and the module is executed. Within a few seconds the new particle traces appear in COVER.

3.2 Plug Ins

COVER provides an interface for programming Plug Ins. For details see COVISE Programming Guide, section COVER Plugin Programming. Below you get a description of some plug ins you may find useful for your current work.

3.2.1 Probe

Probe is a new plugin for 2D probing. To use Probe, select first the Probe button from the menu; a red icon will appear. If the pointer intersects a 2D object (polygon or triangle strips) and the button is pressed, a label will show the coordinates of the intersection (relative to the object) plus scalar and vector data values at that point. The plugin reads the PROBE2D attribute(s) of the grid object which indicate the name(s) of the data object(s). You can configure line length and text font of the label, the format of the text, and a default for the kind of data to be displayed, e.g. TEMP, in covise.config, section VRProbe:

```
VRProbe
{
   LabelLineLen 90
   LabelFontSize 7
   ScalarFormat %s= %.3f
   VectorFormat %s= %.3f  %.3f %.3f
   DefaultSpecies TEMP (e.g. - if not specified: Unknown)
}
```

Additional information:

- don't write anything into the PROBE2D attribute
- add the following line in the section COVERConfig

```
MODULE      VRProbe
```

The label will be shown until a new intersection will be selected or the Probe button will be unselected.

3.2.2 Viewpoints

A viewpoint defines the current position, orientation and scaling factor of the scene. The **Viewpoints** plugin allows to the user to load viewpoints from file and save them to file ot interactively define new viewpoints. It offers a flight through all viewpoints or activated only one selected viewpoint.

The Viewpoint Plugin is activated if the line

```
MODULE VRViewpoint
```

in COVERConfig (as for all plugins) is available.

Viewpoint Definition

Default viewpoints can be defined in covise.config in the section VRViewpoints, and they will be automatically inserted into the list of viewpoints:

```
VRViewpoints
{
    1    S=1    X = 0 y=0 z=0 h=0 p=0 r=0
    10   S=10   X = 0 y=0 z=0 h=0 p=0 r=0
    100  S=100  X = 0 y=0 z=0 h=0 p=0 r=0
    1000 S=1000 X = 0 y=0 z=0 h=0 p=0 r=0
}
```

In addition, and even if there is no "Viewpoints" entry in covise.config, there is a parameter "Viewpoints" in COVER, which contains the name of a custom file where the viewpoints are stored. If no name is

indicated then the file default.vwp will be loaded (if default.vwp doesn't exist it will be created). If a file is specified it will be loaded, and if it doesn't exist, it will be created.

If COVER is started from the console, the custom viewpoints will be loaded using the "-v" option and the path of the .vwp file:

```
cover -v example.vwp
```

The Viewpoints Menu

The button "Viewpoints" opens a submenu with the following entries:

- "SaveViewPoint"
- "Flying mode" - toggles animated flight from current to next viewpoint
- "Flight" - opens a submenu
- "StartRecord" - starts recording viewpoints
- "StopRecord" - stops recording viewpoints
- "First default viewpoint from covise.config" - if one exists
- ....
- "Last viewpoint from covise.config"
- "First viewpoint from custom viewpoint file" - if one exists
- ...
- "Last viewpoint from custom viewpoint file"

By pressing "SaveViewPoint" a new entry, "NewViewpoint", will appear, and it will be saved in the file. The name "NewViewoints" can be changed in the file with a text editor. By chosing a viewpoint and pressing on this entry the viewpoint will be activated.

If "flying mode" is active then an animated flight from the current viewpoint to the selected viewpoint will be started. The selection of viewpoints can also be done using the keys F1-F12.

The "Flight" button opens a submenu with a list of all viewpoints and a button "Run". "Run" starts an automatic flight through all selected viewpoints in the list. Viewpoints can be removed from the flight by deselecting them in the list.

"StartRecord" starts recording viewoints. The viewpoints are saved in vrml format to a file named animation.wrl. "StopRecord" stops recording viewpoints. The recorded viewpoints have to be added to a vrml file and become available in the submenu VrmlViewpoints, as soon as the file is loaded.

3.2.3 Snapshot

This plugin is available when an entry

```
MODULE Snapshot
```

in COVERConfig is present.

When pressing the Snapshot button of the pinboard, a submenu appears, which has a single button as long as you have creted no snapshots. When you press this button, the submenu disappears, and a snapshot will be creted whenever you press the pointer again. A snapshot may encompass several rgb files. One or two files are generated for each screen in a screen selection list. By default this list

reduces to screen in the first entry in the ChannelConfig section of covise.config. You may create your own list by adding a SNAPHOT_SCREEN entry in section *Snapshot* of covise.config.

The rgb snapshot files are created by default in the working directory. You may override this behaviour if a SNAPHOT_DIR entry in section *Snapshot* is present, for instance:

```
Snapshot
{
SNAPHOT_SCREEN FRONT TOP.
SNAPHOT_DIR /usr/tmp
}
```

The generated files have the following structure:
snap{number}_{extra digits}_{left|right}Eye_Screen{Screen name}.rgb. The first number is a snapshot counter. The extra digits have no special meaning, they are only used in order to prevent new file or button names from being repeated. Whenever you create a snapshot, a new viewpoint entry is also created for the Viewpoint plugin, which should also be in use, otherwise the COVER will crash. For these new viewpoints associated with snapshot actions, new buttons are also created in the Snapshot submenu, with the same name as in the Viewpoint submenu. These names have the structure: snap{number}_{extra digits}.

3.2.4 Sketches

You create drawings in 3D space using this plugin. A sketch is a set of lines. A line is defined in this context to be a series of connected points.

The Sketches Plugin is activated if the line

```
MODULE Sketcher
```

in COVERConfig is present.

In order to create a sketch, you should activate the *Draw* button in the *Sketches* menu. Then you may create lines by pressing the pointer and moving it. When it is released, the current line is finished. You may create several lines by repeating this operation. When you are done with one sketch, then you will want to create a new entry in the list of available sketches. You should press the button *NewSketch* in this case. But this is not enough to save the sketch in a file (see below comment on button *SaveSketches*).

The available sketches may be shown or hidden by activating or deactivating the corresponding entry in the menu.

All sketches are saved to the file specified by the COVER parameter *Viewpoints* when you press the button *SaveSketches*, whose action will be eventually preceded by the action of button *NewSketch*. You may edit this file in order to change some attributes of the sketches or their lines: sketch name, color attributes, etc.

The position of the sketching tool with respect to the hand may be parametrised by a pertinent section in covise.config:

```
Sketcher{
ANGLE 5.0
DISPLACEMENT 0.5
SCALE 100.0
}
```

where SCALE determines the size of the sketching tool, DISPLACEMENT stands for a displacement along the local Y axis relative to the sketching-tool size, and ANGLE parametrises a rotation around the local X axis in degrees.

By way of summary, you may read the table below with explanation to the buttons in the submenu *Sketches*. The button *Sketches...* opens a submenu with the following entries:

- "Draw" - enters drawing mode
- "NewSketch" - ends the definition of a sketch and creates a new entry in the list of sketches
- "SaveSketch" - saves all sketches to file
- "First sketch name" - if one exists
- "Second sketch name" - if one exists
- ...

4 The Renderer

4.1 Introduction

In this chapter the main functionality of the COVISE Renderer is summarized. Like the map editor, one renderer is started on every host in a cooperative working session, once the master renderer has been brought up on the master map editor.

The design of the Renderer supports collaborative working (for more details see chapter 5, COVISE CE - Collaborative Working): Basically the Renderer works in a "what you see is what I see" mode. This is called the Master/Slave Mode or Tight Coupling. It means, that every partner in the session has the same viewpoint in respect to the rendered geometry objects. Only the master has the ability to change the view in the other renderers. On the slave side it is possible to change the camera position independently from the others as long as the master isn't changing anything. As soon as the master performs an interaction, the slaves automatically become synchronized and updated. (Strictly speaking, there is a slight difference between "Master/Slave Mode" and "Tight Coupling": "Master/Slave" causes the slave renderer to be updated at the end of a move only, whereas "Tight" makes a contiuous update. The two possibilities have been introduced due to performance considerations.)

Alternatively, the master has the ability to switch to a second mode called Loose Coupled Mode. When this mode is enabled, every partner has full access to all Renderer functionalities without disturbing the other partners setup and view. This mode is convenient when the partners have stopped their discussion about the current rendered objects and want to do some postprocessing on the data, like changing some colors, adding light sources, saving or printing etc..

The discussion on the data is supported by introducing Telepointers. A telepointer marks a position in the renderer's window to guide the other partners to interesting details on the screen. Each renderer has a telepointer attached to the current mouse position, which is sent to the remote renderers.

In addition, the renderer supports stereo viewing mode with the Crystal Eyes shutter glasses as well as with various autostereoscopic viewing devices. It also supports the Spaceball or the DLR Spacemouse for 6Degree of Freedom interaction.

4.2 Getting started

To start the Renderer simply select the module named Renderer in the category Renderer in the MapEditor. After a few moments the renderer's icon 4.1 is displayed in the MapEditor canvas and the renderer main window appears on the screen as shown in 4.3.

Figure 4.1: The Renderer Icon

Note that you can resize the renderer according to your needs, but reducing the window size may hide some of the menu components. By clicking on the module setup button in the Renderer icon, the data object and parameter list for the Renderer appears (4.2).

As you can see, no parameters can be set or adjusted, and there is currently only one input port called DO_Geometry. In the future there may be additional input ports, e.g. for pixel images. Unlike other

application modules in the COVISE environment, the renderer has it's own Motif based point and click user interface. You can connect all modules with geometry output ports to the renderer's input port. The renderer will accept any number of input objects. After an execution of a complete module network, the renderer will appear highlighted while new objects from local memory or remote machines are sent into the module. New rendered objects will be shown in the geometry objects list in full name. You can find out your point of view in respect to the scene by looking at the coordinate axes and their orientation. If you cannot see objects just select the View All icon on the right side of the drawing area.

You see the objects as you would look through a camera lens. While pressing the left mouse button and dragging the mouse around in the Viewer Area, you can move the camera around the scene. This allows you to rotate the whole view around a point of interest using a virtual trackball. The viewer area uses the camera's focal distance to figure out the point of rotation, which is usually set to be in the center of the scene. You can also translate the camera in the viewer plane by using the middle mouse button as well as zoom (getting closer or moving backward from the scene center) by using both left and middle mouse buttons. The viewer area also supports seeking (see description of viewer pop-up and decoration). You can also use the decoration thumb wheels around the viewer area for most of these operations. Changing the camera means changing the view in respect to all visible objects. If you want to do editing operations like scaling certain objects or changing some colors, you need to switch to the Edit Mode (or Pick Mode) first. Therefore, press the Pick Mode icon on the right side of the viewer area. The cursor changes to an arrow shape and you can select objects now by clicking on them with the left mouse button. A wireframe bounding box appears around the selected object and the name of the object gets highlighted in the geometry object list. Now it is possible to edit this object by bringing up multiple manipulators and editors, all explained in detail in the next sections. If you want to return in viewing mode click on the View Mode icon. Note that editing operations are only possible in master mode. Only the master has access to the menu bar functionality. For the slave renderers the menu bar is disabled.

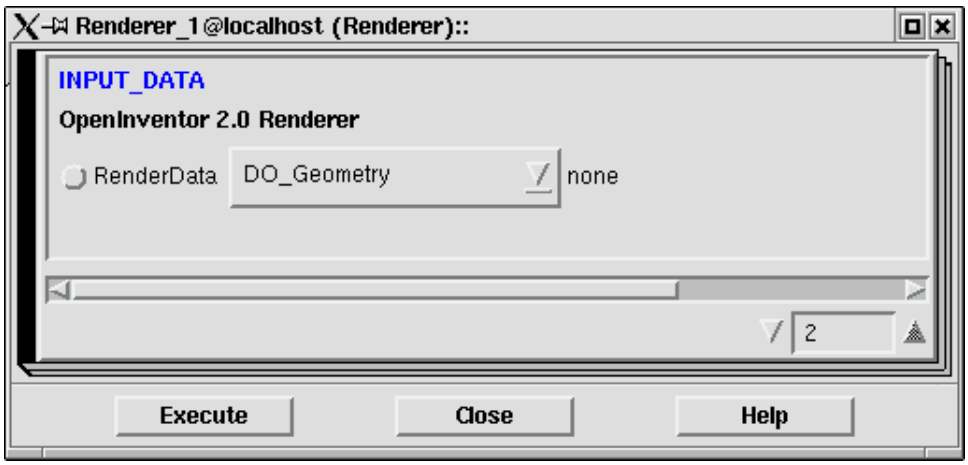


Figure 4.2: Renderer Module Setup in the MapEditor

4.3 Cooperative Working Modes

see Chapter 5, COVISE CE, section MasterCtrl, subsection Synchronization

4.3.1 Using the Telepointer

see Chapter 5, COVISE CE, section MasterCtrl, subsection Telepointer

4.4 The Renderer's User Interface

In the following sections the components of the renderer user interface are discussed.

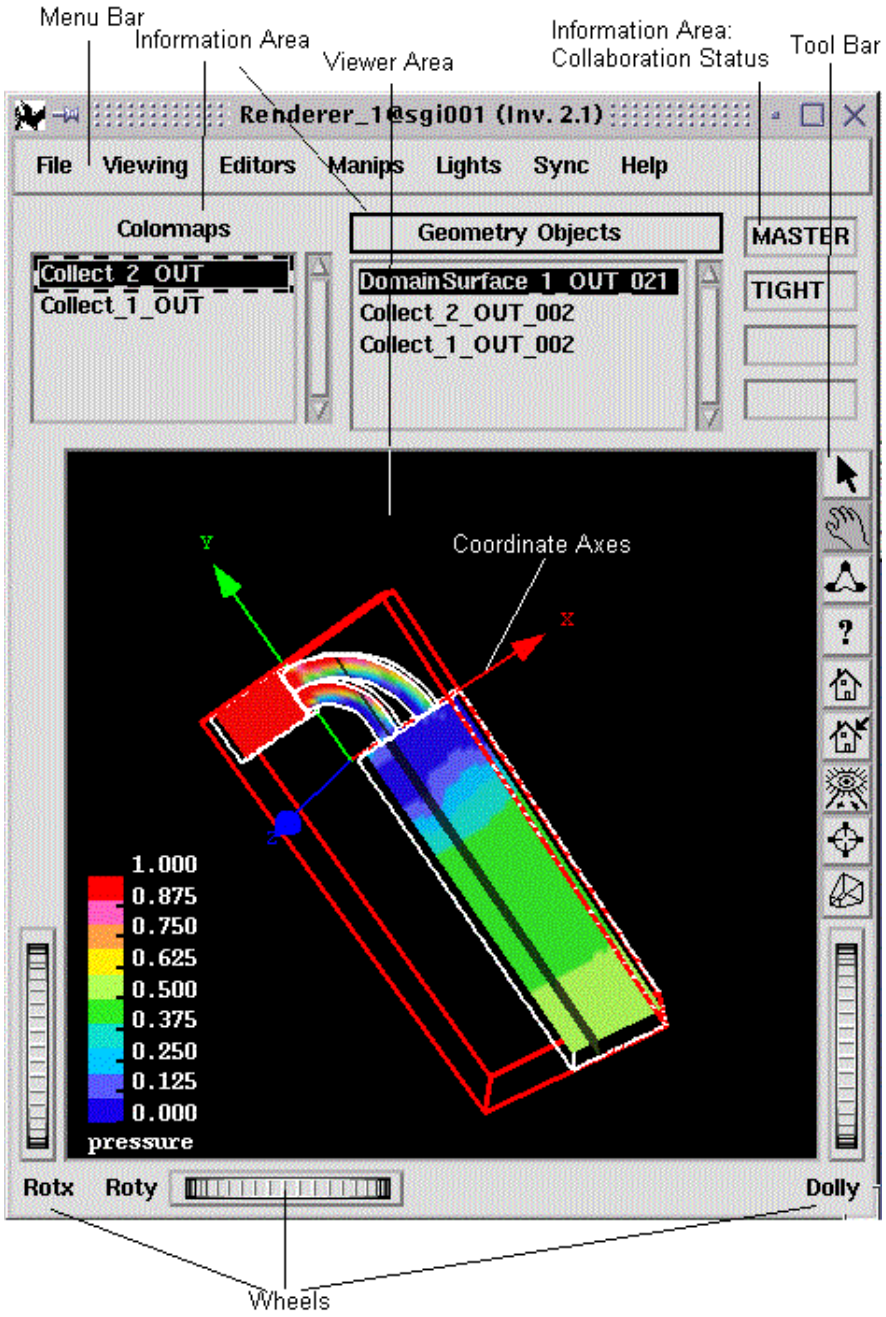


Figure 4.3: Renderer Main Window Components

4.4.1 The Viewer Area

In the viewer area objects are displayed and can be manipulated in several ways. The coordinate axes show the current view orientation.

Direct Interaction

Using the mouse buttons in viewing mode affects the camera position, the line of sight, and the angle of vision in respect to the scene. In the default viewing mode, the mouse buttons have the functionality as described earlier. In edit (pick) mode, pressing the left mouse button selects the object under the mouse cursor. When seeking is enabled by clicking on the seek icon, pressing the left mouse button starts seeking to the selected point.

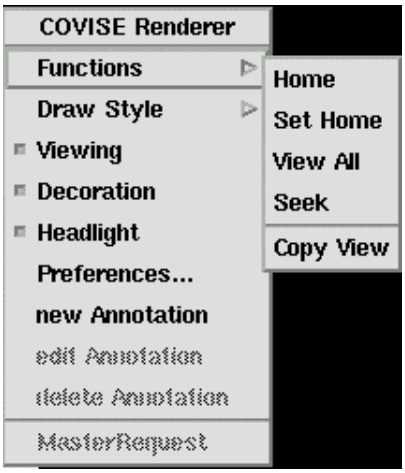


Figure 4.4: The Viewer Popup Menu

The Viewer Popup Menu

The popup menu (4.4) is activated by clicking the right mouse button while the mouse pointer is positioned in the viewer area. The popup menu contains several items and sub menus. These are:

- **Functions**: The items of this popup sub menu correspond to the icons on the right side of the viewer area.
- **Draw Styles**: There are two drawing modes (Still Mode and Move Mode) and seven different drawstyles for each of these modes, among which the user can choose. Move Mode is automatically enabled when interactively moving objects or the camera using the mouse. The objects may be rendered in a simpler style when selecting one of the menu items. This is especially useful on slower machines; thus z-buffering is turned off while rendering in these styles. The different mode items are:
  - As is
  - Hidden Line
  - No Texture
  - Low Resolution
  - Wireframe
  - Points
  - Bounding box

The last three items of the drawstyle sub menu in the viewer popup menu activate single buffering, double buffering or the switching between single buffering during manipulation and double buffering otherwise.

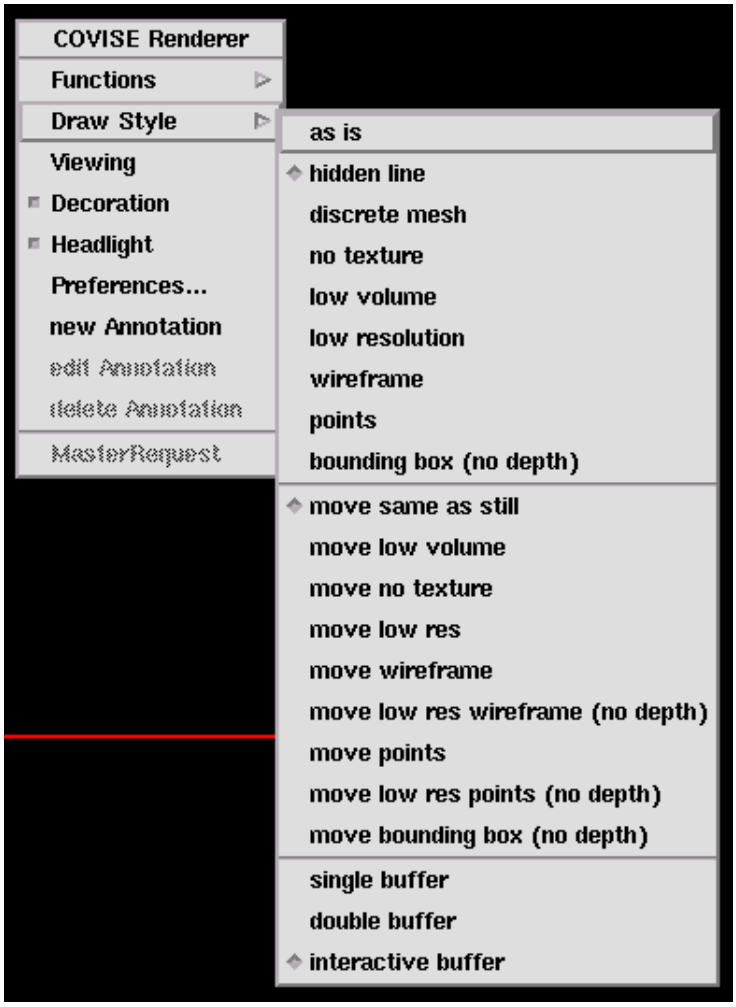


Figure 4.5: Available Drawstyles in the Viewer Popup Menu

You can see different viewing modes in 4.6, 4.7, and 4.8. The hidden line representation removes all lines which normally could be seen shining through in a wireframe representation.

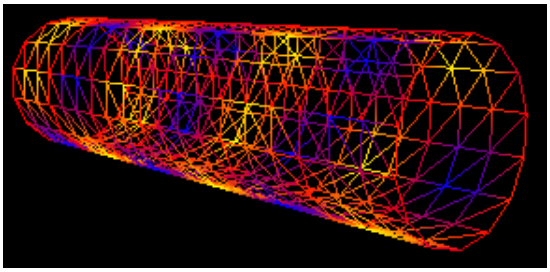


Figure 4.6: Wireframe Representation

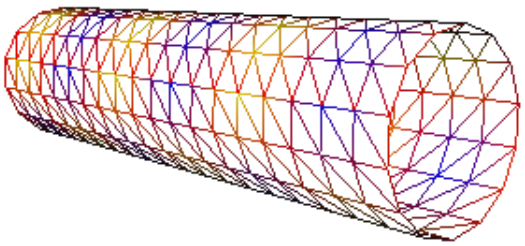


Figure 4.7: Hidden Line Representation

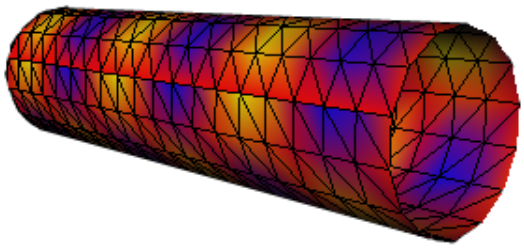


Figure 4.8: Discrete Representation

- **Viewing**: Toggles between View and Edit (Pick) mode. When picked, a red bounding box appears surrounding the selected object (4.9).

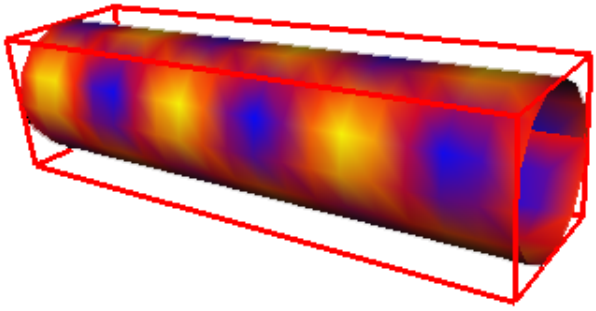


Figure 4.9: A Selected (Picked) Object

When you click on the background in the viewer area the object becomes deselected again. You can only select one object at a time.

- **Decoration**: Hides and shows the decoration around the render area. The render area appears a bit enlarged while decoration is hidden.
- **Headlight**: Switches the headlight on and off. If you are in PHONG shading mode and no other lights are active, the objects may become invisible depending on the direction of the normals on the object surface. It is possible to add more lights to a scene. This is described later in this chapter.
- **Preferences**: You can select options from the Preference Sheet:

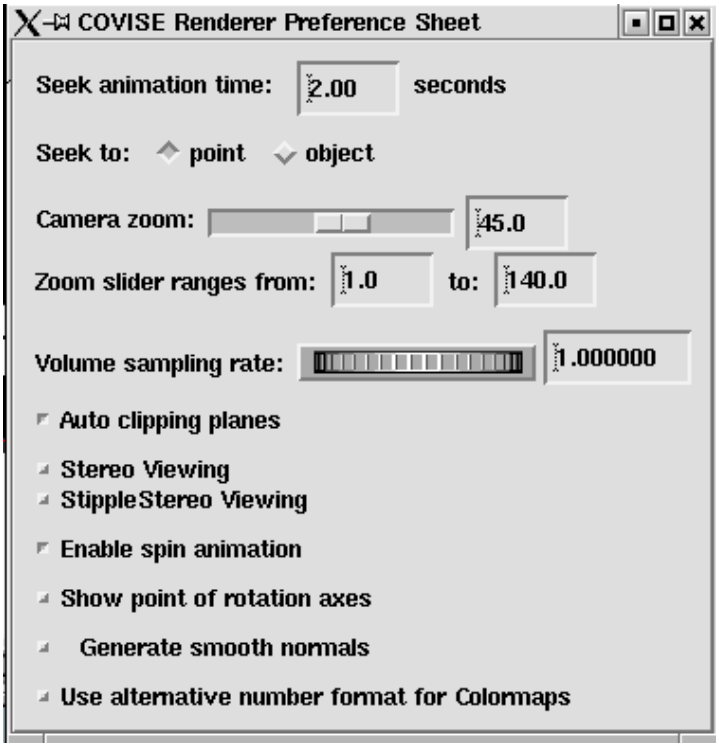


Figure 4.10: The Preference Sheet

A menu appears in which defaults for the seek mode, zoom slider bounds, clipping planes and stereo viewing can be set, or an **alternative number format for colormaps** can be specified: This field can be used to specify formats of the numbers along the color legend. It must be a float format for the "printf" format as specified in the unix manual pages and should be left-justified.

```
Examples: Values 0 0.1 0.2 0.3 0.4 0.5

Format: %-.3f    -->   0.000 0.100 0.200 0.300 0.400 0.500
        %-.2f    -->   0.00 0.10 0.20 0.30 0.40 0.50
```

The Volume sample rate thumbwheel is needed for Volume Rendering (see Appendix).

When Spin Animation is enabled, objects can be rotated around in an animated fashion in viewer mode.

- **Annotation** (new, edit, delete): With the items of this sub menu (new Annotation / edit Annotation / delete Annotation) you can add a description to the Renderer image, like "isosurface" in the figure below.

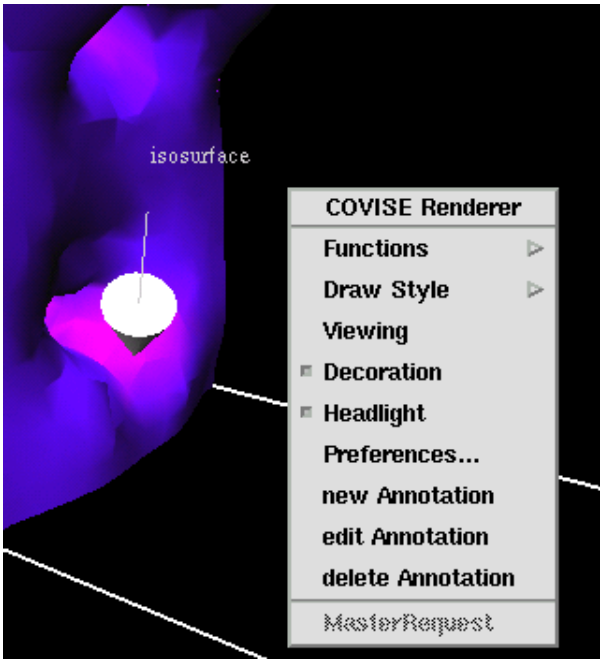


Figure 4.11: Annotion function

Switch to pick mode and click on the detail you want to explain: You can now (using a popup with "apply")

  - add a **new Annotation**
  - **edit** an existing **Annotation**
  - **delete** an **Annotation**

Please note:

  - Annotations can be saved as part of a map
  - Annotations are "static" - they do not move e.g. with an isosurface if the isovalue is changed

- **MasterRequest**: same function as MasterCtrl in MapEditor

The Decoration Area

The decoration consists of three thumb wheels for rotating (Rotx, Roty) and zooming (Dolly) as well as a zoom slider trim (Zoom) and six viewer icons to the right side of the viewer area. These icons are shortcuts for some of the viewer pop-up functionality. From top to bottom there are icons for

- switching between View and
- Edit (Pick) Mode
- Head Tracking Mode (currently not implemented)
- invoking the help browser (Help) - not implemented, use help button in menu bar instead
- resetting camera position to the home position (Home)
- saving a new home position for the camera view (Set Home)
- viewing the whole scene (View All)
- seeking to a certain point of the scene (Seek)

4.4.2 The Menu Bar

The menu bar of the renderer window is shown below.

Figure 4.12: Renderer Menubar

File Menu

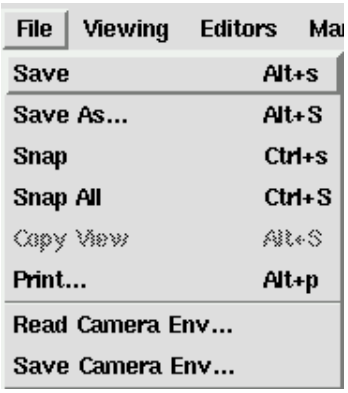


Figure 4.13: The File Menu

- **Save**: The current objects are saved in Inventor 3D format. Programs reading this format like IRIS Explorer or IRIS Showcase can load this objects and allow further usage and postprocessing of the 3D data.
- **Save as**: Save the whole scene. A file selector box appears where directory and file name can be selected.
- **Snap**: Take a snapshot of the viewer area. Format of the snapshot files is .tiff (changed with Rel. 5.2.3). Creates an error dialog if offscreen rendering is not possible due to low colordepth. Offscreen rendering requires at least a 24bit true color. Same applies to Snap all.
- **Snap all**: Take a series of snapshots of the viewer area.
  You can use this series of snapshots in order to **generate a simple movie**.
  Example on SGI: call **'mediaconvert'** and fill in the entries as shon below

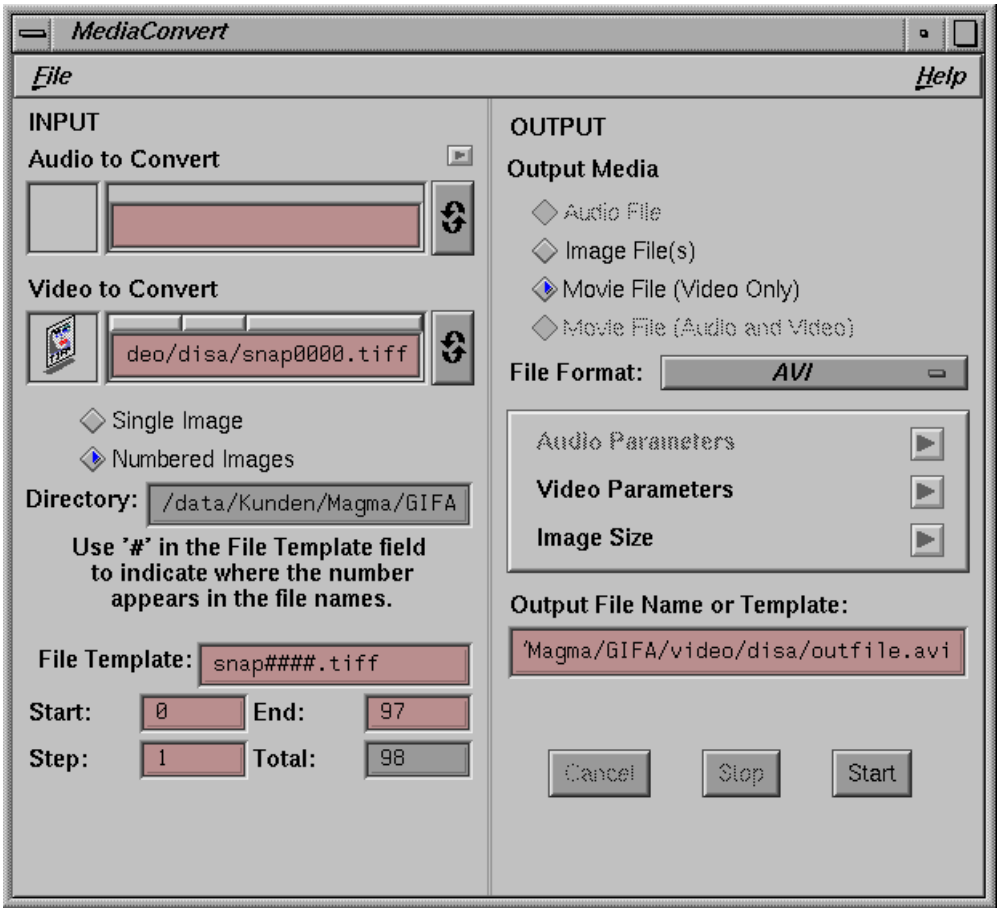


Figure 4.14: MediaConvert - Movie on SGI

- **Copy View**: The currently selected object is copied to a buffer from which other programs like IRIS Showcase can directly paste the 3D object into their application.
- **Print**: It is possible to save the currently visible scene in an Postscript file or to send the postscript output directly to a printer. The available printers are listed below in the printer list. The output quality and print size in inches can be adjusted The page format can be chosen between landscape or portrait.

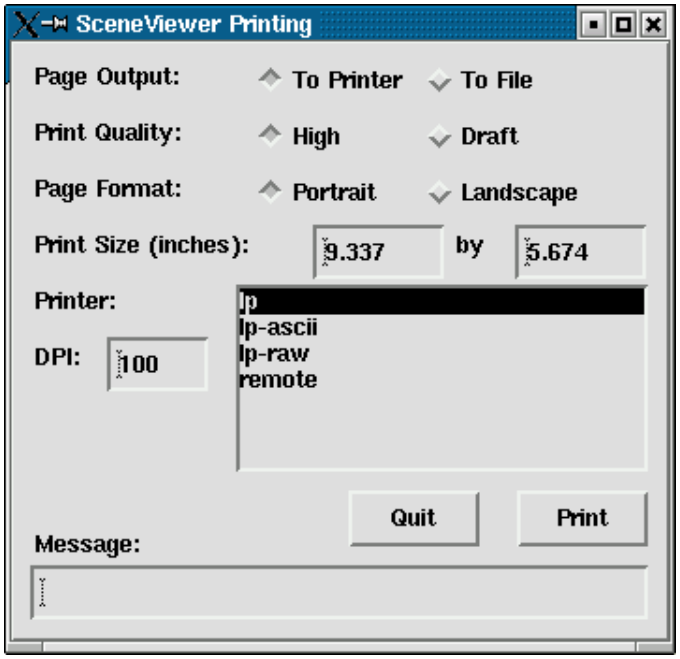


Figure 4.15: The Printing Menu

- **Read/Save Camera Env...**: Restore/Save the camera environment

Viewing menu

The viewing menu is shown in 4.16.

- **Pick/Edit**:

  By default the renderer is in the View mode. The viewer uses a virtual trackball to rotate the scene graph around the point of interest. If you want to change the view of a scene but a specific object in respect to other objects, you have to switch from the View mode to Pick/Edit mode. In Edit mode the outlined hand cursor changes to an arrow shape cursor. If you click on an object with the left mouse button, the object becomes selected and highlighted by a red wireframe box which now surrounds the object. You can select only one object at a time. If you have opened any editors or enabled manipulators, these will be attached to the selected target object for further editing. If you switch between objects by clicking on a different object all manipulators and editors automatically become attached to this object.

Figure 4.16: The Viewing Menu

- **Light Edit Mode**:

  Enabling this mode lets you interactively edit the current visible light sources in the scene by using the mouse.

- **Fog**:

  This item affects the environment of a scene to simulate various atmospheric effects such as fog, haze, pollution and smoke which are grouped under the term fog.

- **Anti-aliasing**:

  This technique is useful to eliminate or reduce jagged lines and make objects drawn on the screen look smooth. Enabling this item reduces drawing speed.

- **Screen Door Transparency**:

  This and the next three items affect the transparency quality level. Screen door transparency is the default and the only supported mode on some machines. For transparency details refer to the editor's section. Screen door transparency uses GL patterns for achieving the transparency effect.

- **Blended Transparency**:

  uses GL alpha blending.

- **Delayed Blended Transparency**:

  uses GL alpha blending, opaque objects are rendered first, then transparent objects.

- **Sorted Blended Transparency**:

  uses GL alpha blending, opaque objects are drawn first, then transparent objects. Additionally the objects are sorted by their distance from the camera and are drawn from back to the front.

- **Edit Background Color**:

  Invokes a color editor for changing the background color of the render area (default is black).

- **Hide Coordinate Axes**:

  Toggles between hiding and showing the three coordinate axes. The axes are on by default.

- **Clipping Plane**: Cut Geometry

Editors menu

Figure 4.17: Editors Menu

- **Material Editor**:

  The material editor is used for customizing objects by interactively changing values for ambient, diffuse, specular, transparent, emissive and shininess elements and immediately seeing the effects of these changes.

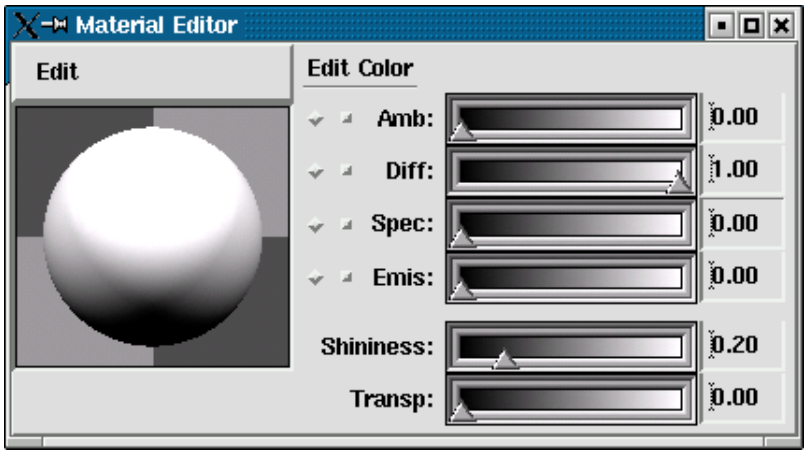


Figure 4.18: The Material Editor

The diffuse color is the object's base color specified in the color array of the renderer geometry input data objects. If no colors are specified, the color of each vertex of the object is set to RGB [1.0 1.0 1.0] default. Editing the diffuse color of those objects affects all vertices of the object, thus the whole object changes its color. If one color is specified for the whole object (color binding OVERALL) all vertices of the object are colored according to this value. If you edit the diffuse color of these objects, also all vertices are affected by color changes. If vertex based objects such as polygons or lines with colors attached per vertex (color binding PER_VERTEX) or per face (binding PER_FACE) are present, only the first vertex is affected by changes of the diffuse color field, therefore editing the diffuse color of those objects is not very useful. The next items affect the whole object in any case. The Ambient Color is the reflected color of an object in response to the ambient lighting in the scene. The default value for this field is [0.2 0.2 0.2]. The Emissive Color is the light caused by self illuminating objects. The default for this field is [0.0 0.0 0.0], which means the object is emitting no light. The degree of shininess of an object's surface is for e.g. achieving metallic effects on the surface of an airplane wing. The value ranges

from 0.0 (default) for a diffuse surface with no shininess to 1.0 for a highly polished surface. Let us assume there are two objects present by one object covering the other, where one cannot see the covered object. By adjusting the Transparency Level of the covering object you can see either both (values larger than 0.0) or only the previously covered object (value 1.0).

- **Color Editor**:

  The color editor lets you interactively change the color properties of an object, a light source or the background color of the render area. You can set RGB or HSV values or pick a color directly from the color wheel. By selecting Manual from the edit menu bar item you can prevent changes being reflected immediately in the object until you are ready. Use the two color squares to test new colors and store the previous one. By clicking on the three pads beneath the squares, you can switch back and forth between colors. The new color is always on the left and the previous color on the right. You can send the new color to the right square, or the old color to the left square. RGB values range from 0.0 to 1.0 for the red, green and blue color component, where [0.0 0.0 0.0] is black and [1.0 1.0 1.0] is white.

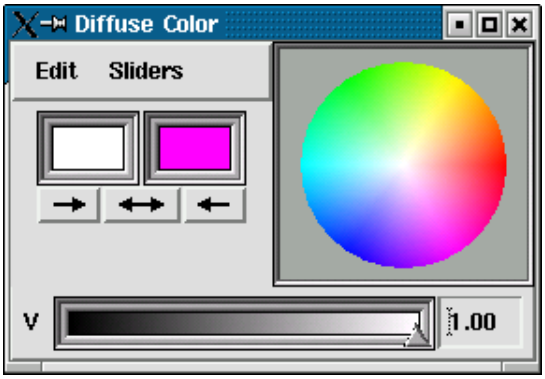


Figure 4.19: The Color Editor

- **Object Transform**:

  Transform sliders are useful to change the position of objects in respect to each other or to scale an object to make it appear larger or smaller on the screen. If you click on an item in the transform slider set sub menus appear in which you can do the desired editing operations by adjusting sliders with the mouse or typing exact values using input fields. There are three different widget layout styles available, simply click on Style in the slider menu. Note that the changes only affect the currently selected object in the scene. Translation changes the position of an object in the scene. Scale changes the size of an object. Rotation changes the orientation of the object in the scene. Scale Orientation changes the orientation for scale operations. Center changes the center around which rotations take place.

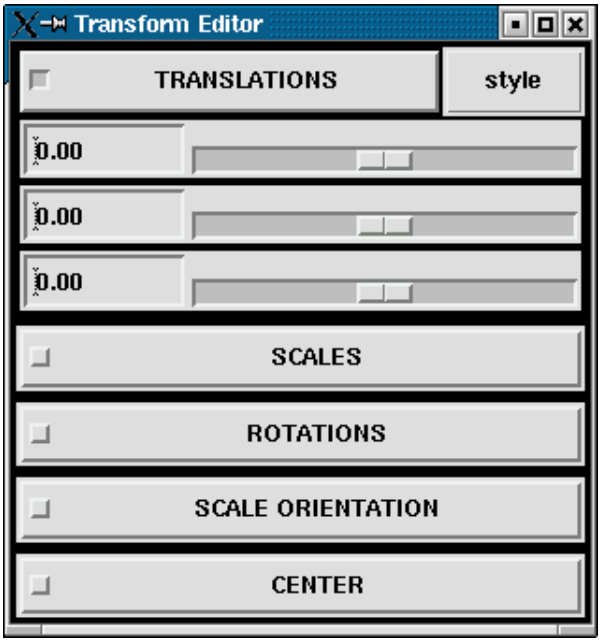


Figure 4.20: The Transform Editor

- **Part Editor**:

  If the geometry objects displayed by the Renderer can be identified (in case of modules using finite elements) you can use the **COVISE Part Editor** to select which parts of the geometry will become visible or invisible and, optionally, which part is fixed during movements.

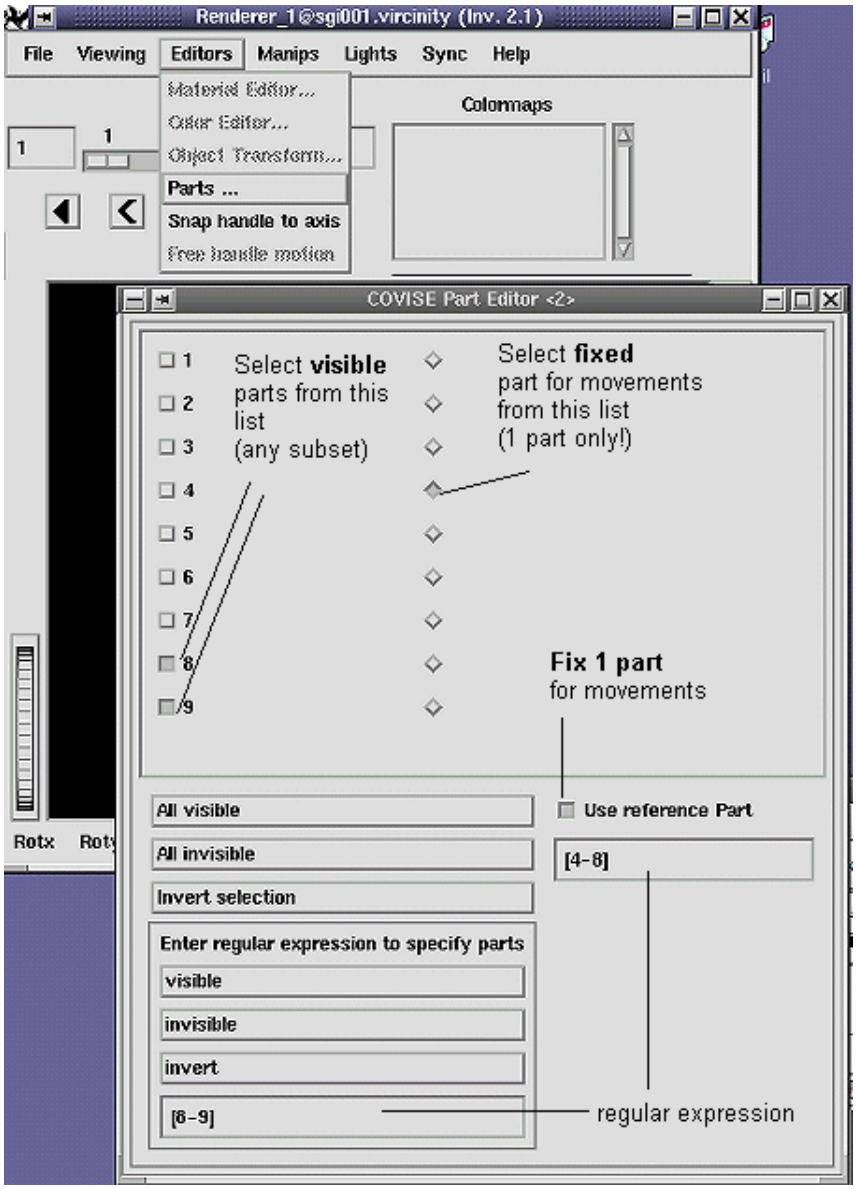


Figure 4.21: Part Editor

The **left side** of the Part Editor window provides the functions to select which parts are **visible**; you have 3 possibilities:

- Select any subset of parts out of the selection list (toggle switches,any subset)
- Set all parts visible/invisible or invert your selection
- Specify the subset of parts by a regular expression and press RETURN

On the **right side** you can (optionally) select a **reference part** that will be **fixed** during movements; to specify this reference part you can use 2 possibilities:

- Select this part from the list (toggle switches, 1 part only)
- Specify a regular expression and press RETURN; the first part matching the regular expression is fixed.

- **Interactors (Snap/Free handle)**:

  The last two options of the Editors menu item have been added to select options for an **Interactor**. If you want to move e.g. a Cutting Surface, you can attach an interactor to it. An interactor attached to a point of a Cutting Surface consists of

  – a **tangential plane** (reduced to a square) at that point

  – a **normal** at that point

  (see example below)

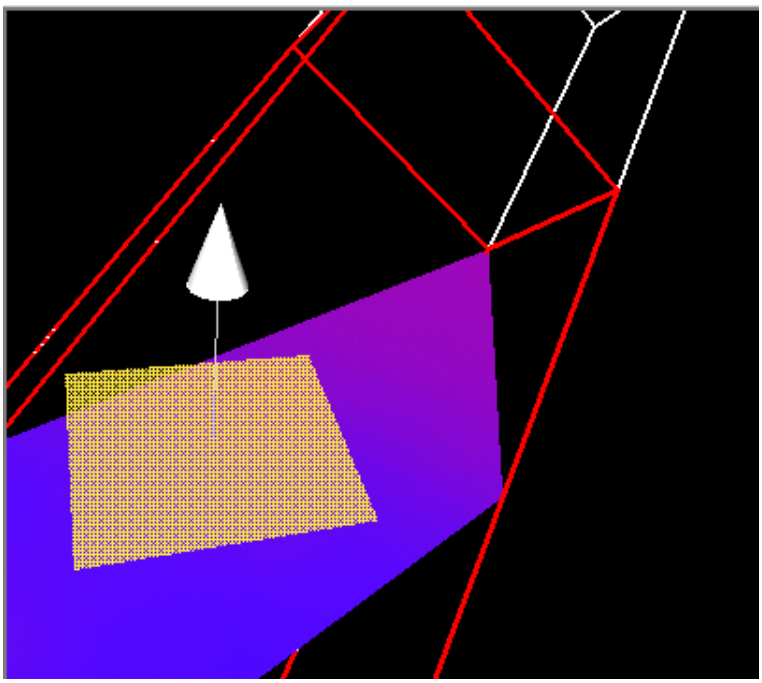


Figure 4.22: Interactor

You attach an interactor by clicking on a point of the Cutting Surface.

Note: You must be in pick mode and select (click on) the Cutting Surface before you can attach an interactor

You can

– **rotate** the Cutting Surface by using the normal (arrow) as a handle

– **translate** the Cutting Surface by pulling the plane

You use the option

– **Snap handle to axis** in order to in order to enable ...

– **Free handle motion** in order to disable the orientation of CuttingSurfaces normal to coordinate axis

Manips menu

Manipulators are used for direct manipulation of a certain object, like the editors explained in the last section.

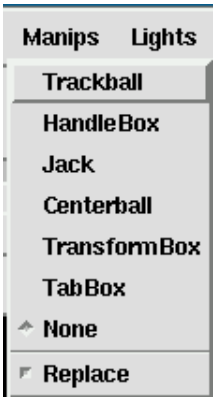


Figure 4.23: The Manips Menu

This way of manipulation is more direct than using editors, but less precise than using the sliders. To attach a manipulator to an object, switch to the picking mode and select a manipulator type in the Manips Menu shown in 4.23.

Now click on the desired object. The manipulator appears and surrounds the object. There are different manipulators to transform, rotate, scale, and move an object in the viewer.

- **Trackball**:

  This manipulator is for rotating and scaling an object. It appears as a transparent sphere around the selected object.

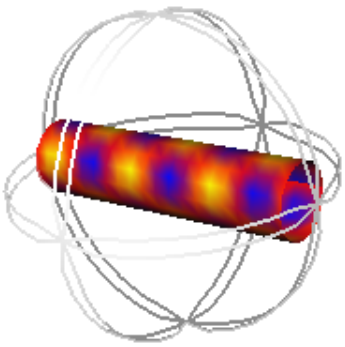


Figure 4.24: Object with Trackball Manipulator Attached

- **Handle Box**: This inserts a transparent cube into the scene that allows the user to scale and translate the object by moving the mouse in various ways. Use the SHIFT and ALT keys with the left mouse button to achieve specific effects for both the trackball and the handlebox manipulator. (see 4.25)
- **Jack**: The object can be zoomed and rotated.
- **Centerball**: Is for moving the center point of rotation for an object. Afterwards the object can be rotated around the new rotation point.

- **TransformBox**: This manipulator is for transforming the selected object.
- **TabBox**: This lets you scale an object by doing a click-drag-release motion with the mouse after clicking on the green control points.
- **None**: This is the default. If an object gets picked, no manipulator is attached to the object.
- **Replace**: If a different manipulator is selected from the list the currently active manipulator is either replaced or stays attached.

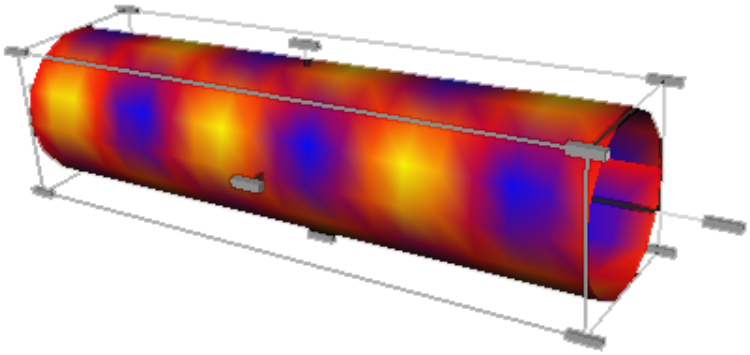


Figure 4.25: Tube Surrounded by a Handlebox Manipulator

Lights menu

The lights menu is for creating, editing, and removing light sources in an object scene. This is a feature used for changing the appearance of an object by changing its illumination. Light information is currently not sent to other renderers in a cooperative working environment. Each entry in the menu is explained now in detail.

Figure 4.26: The Lights Menu

- **Lightmodel BASE_COLOR**: Each object has its own base color also called diffuse color. If no colors are specified, the objects are colored white over all faces or vertices. When the base color model is enabled (the default), all objects are rendered by taking only their diffuse color into account. If it is disabled all objects are PHONG shaded. The PHONG lighting model takes into account all light sources in the scene and the object's surface orientation (the normals on faces or vertices) with respect to the lights to generate a realistic smooth shaded 3D appearance of an object. Scientists often prefer to see only the real colors defined for the object without shading effects, so switching between the two modes is introduced here.
- **Create Dir Light**: This creates a light which illuminates uniformly along a particular direction.
- **Create Point Light**: A point light, like a star, radiates light equally in all directions from a given location in 3D space.
- **Create Spot Light**: A spot light illuminates from a point in space along a primary direction. Its illumination is a cone of light diverging from the light's position. This feature is hardware dependent. If not supported, a spotlight appears as a point light.
- **Ambient Lighting**: This is used for the PHONG lighting mode, it lets you edit the ambient ligthing in the scene.
- **Turn all ON**: Turns all currently defined light sources on.
- **Turn all OFF**: Turns all currently defined light sources off.
- **Show all Icons**: Shows the icons of the currently defined light sources.
- **Hide all Icons**: Hides the icons of the currently defined light sources.
- **Headlight**: This is the default light. A sub menu lets you edit the color of this light or removing it from the scene. The icon for the headlight is turned off by default. If you create new lights, new entries will appear below.

Figure 4.27: The Spot Light Icon

- **New lights**: are shown by placing the light icon at a default position in the scene. These lights can be edited interactively with the mouse after turning on the Light editing mode. To edit the properties of a light you can also select Edit from the sub menu of the Headlight item. The edit window appears, displaying the light you have selected. You can change the intensity of the light emanating from the source by moving the intensity slider. You can also adjust the angle at which the light shines on the object by clicking on the directional arrow and changing its position in the window. Editing the color of the light brings up the color editor.

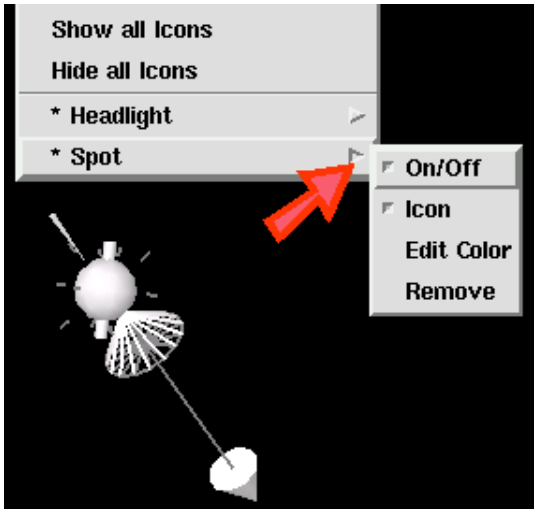


Figure 4.28: New Light Entries

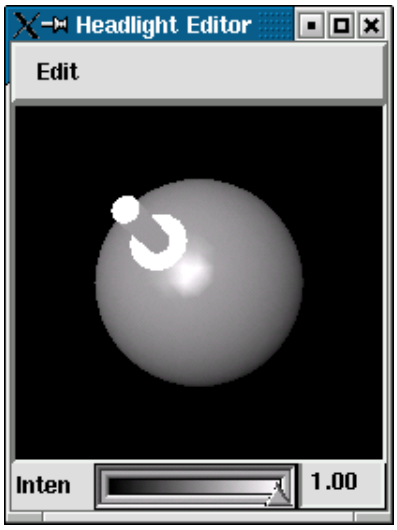


Figure 4.29: The Light Editor Menu

Sync menu

Figure 4.30: The Sync Menu

see Chapter 5, COVISE CE, section MasterCtrl, subsection Synchronization

Help

Pressing Help provides you online help for the Renderer - but you can easily branch e.g. to help for MapEditor or Modules.

4.4.3 The Information Area

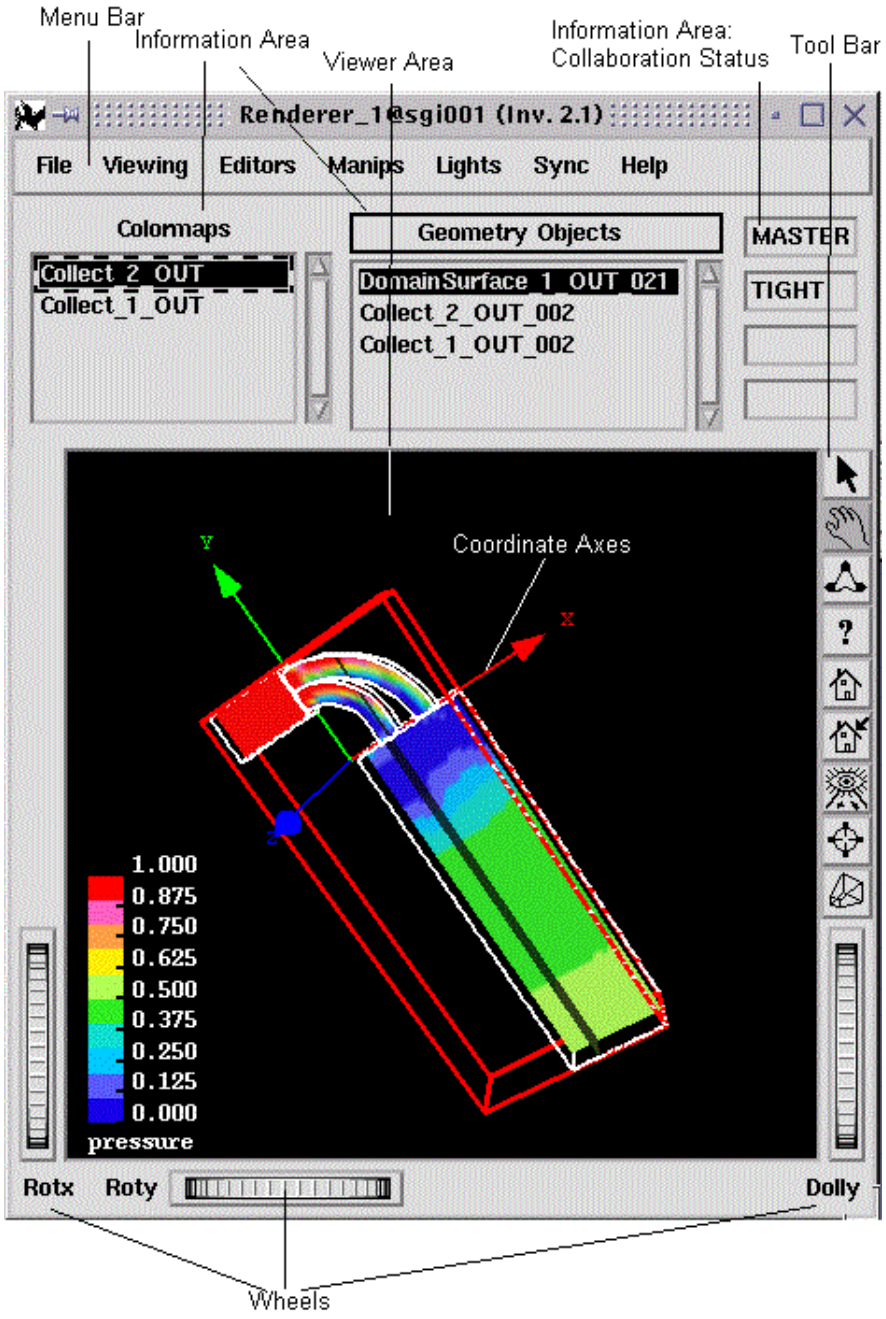


Figure 4.31: Information Area of the Renderer

On the left side of the information area, the list of currently displayed geometry objects is shown (together with the colormaps used).

If you click on a certain object in the render area the name of the object gets highlighted in the object list. It is also possible to select an object in the render area by clicking on it's name in the object list. The red bounding box appears around the selected object in the render area to highlight the selection. Thus, similar objects can be distinguished by their unique name.

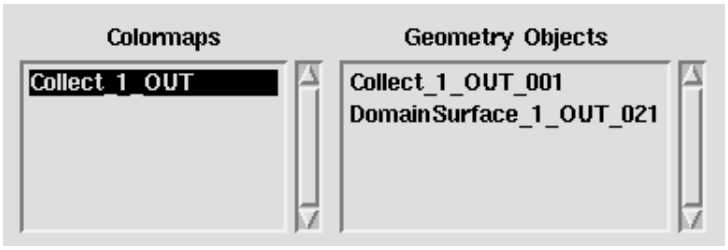


Figure 4.32: List of Current Geometry Objects and Color Maps

On the right side of the information area there are four lines; the first two display the collaboration status of the renderer:

- **Interaction Mode**: Shows whether the renderer is master or slave.
- **Synchronization**: Tells whether tight, master/slave (=SYNC), or loose coupling is enabled between the renderers in the environment.
- **Rendering State**: - obsolete, not used
- **Rendering Time**: - obsolete, not used

4.5 Using Spaceball and Spacemouse

If the Spaceball or the DLR Spacemouse is connected to your workstation, you are able to manipulate the geometry objects in 3D space in a six degrees of freedom fashion. The device should beep two times at renderer startup time when initialization of the device was successful. To move an object around select the object in picking mode. The device is now attached to the selected object. Some of the device buttons provide some additional functionality:

- Button 1: Disable/enable rotation
- Button 2: Disable/enable translation
- Button *: Set home selected object
- Button 3: Set home all objects

If no object is selected, the spacemouse changes the viewpoint in respect to the scene by changing the current camera position.

4.6 Stereo Viewing Mode

Some platforms support stereo in a window viewing. Stereo viewing is enabled by choosing Stereo Viewing in the renderer's preference sheet. You return to the default mode by deselecting Stereo Viewing in the preference sheet or typing in a shell window:

/usr/gfx/setmon -n 72HZ or /usr/gfx/setmon -n 60HZ depending on the type of monitor attached.

4.7 Head Tracking Mode

currently not implemented

Figure 4.33: Stereo mode in the preference sheet

5 Volume Rendering in COVISE

For volumetric scalar data, in addition to cutting planes and iso-surfaces, COVISE offers a direct volume rendering method based on texture hardware. This technique displays entire volume datasets. Transfer functions are used to determine the visual appearance of the datasets. The volume rendering functionality of COVISE was originally developed as part of the project VIRVO (Virtual Reality Volume Rendering) at HLRS.

Please note:

The **Volume Rendering** function has been provided as a **preversion** together with COVISE version 5.2. You gain additional functionality but you might encounter minor problems.

5.1 Volume Rendering Basics

This chapter will give some basic information about volume rendering in COVISE. It will describe what types of volume data can be processed and how the user can display them.

5.1.1 Transfer Functions

Since scalar volumetric data represent a solid 3D block of data values, the user needs a way to look inside of the block. A simple way to look inside is to clip the block along a plane, a more sophisticated method is to assign opacities to the data values. Opacity is the opposite of transparency: the higher the opacity, the lower the transparency. The assignment of opacity values to data values is defined by a transfer function. In addition to the transfer function for opacity, there is a transfer function that assigns colors to the scalar values. In Figure 5.1, both transfer functions are depicted: the opacity function is drawn as a line, the color function is represented as a color gradient. On the desktop, a ColorEdit module serves as a transfer function editor, the VR renderer COVER has its own built-in editor which comes with the Volume plugin and is displayed as soon as volume data is loaded.

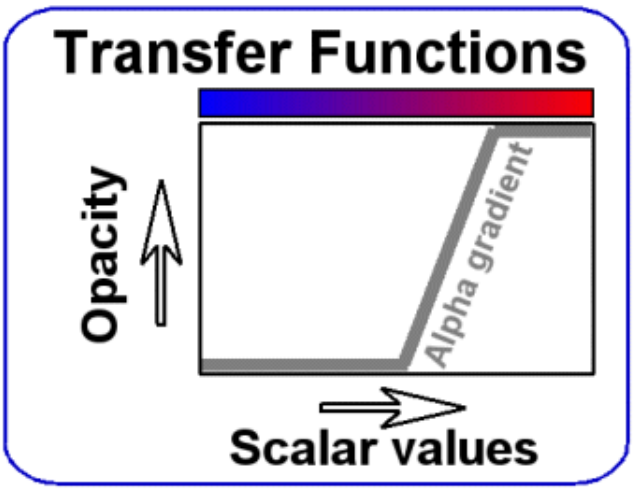


Figure 5.1: Opacity and color transfer functions

5.1.2 Rendering Technique

Depending on the available graphics hardware, either 2D or 3D textures are used for displaying the volume data. If only 2D textures are supported, three sets of textures have to be stored in texture memory, one for each principal axis. For 3D textures the volume data only needs to be stored once. For technical reasons, on SGI machines each voxel occupies at least two bytes of texture memory, even if only 8 bits per voxel are stored.

The volumes are displayed by drawing them slice by slice (see Figure 5.2). The number of slices drawn determines the rendering speed: the faster the graphics hardware, the more slices can be drawn and the higher the image quality. The slices are always oriented in a way that their normal vectors point towards the user, so that the user never looks in-between slices. The number of slices that can be drawn at interactive rates depends on the size of the volume object on screen. This is due to the pixel fill rate being the limiting factor.

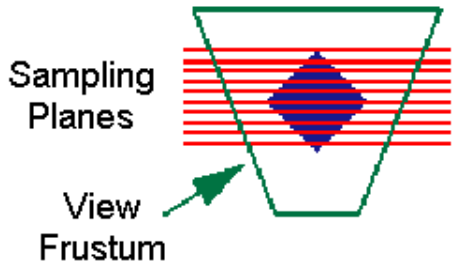


Figure 5.2: Slicing approach for texture based volume rendering

5.2 COVISE Modules

In order to work with volumetric data, a dataset that is compatible to the volume rendering subsystem needs to be created. Compatible data must be located on a cartesian grid, which means that the coordinate axes must be perpendicular to each other, and the data values must be distributed equally on each coordinate axis. There can be different sample distances on each coordinate axis, but not within an axis. If the source data is not on a cartesian grid, it has to be resampled with the appropriate COVISE modules.

The total size of texture memory required for rendering can be computed by multiplying the number of voxels in each dimension with one another and with the number of byes per voxel. For example, a 16 bit per voxel dataset with 256 x 256 x 256 voxels requires 256x256x256x2 bytes = 32 megabytes of texture memory. If the data does not fit entirely into texture memory, it either has to be swapped in and out, which is time consuming, or it does not load at all. In the latter case, a white volume dataset is displayed.

Volume data in COVISE is internally represented as one of the following data types:

- 8 bit per voxel scalar data
- 16 bit per voxel scalar data (usually only the most significant 12 bits can be displayed by the graphics hardware)
- 24 bit per voxel RGB data: 8 bit are stored for each color component
- 32 bit per voxel RGB+scalar data: the scalar value is used as a look-up into the opacity transfer function and for rendering, the color components are multiplied by the resulting value Module ReadVolume

File Extension	Description
rvf	Raw Volume File
xvf	Extended Volume File
avf	ASCII Volume File
tif, tiff	3D TIF File (2D TIFF not supported)
dat	Raw volume data (no header) - automatic format detection
rgb	RGB image file (SGI 8 bit grayscale only)
pgm	Portable Graymap file (P5 binary only)
ppm	Portable Pixmap file (P6 binary only)

In COVISE, Volume data can either be computed at runtime, or it can be read from disk using the module ReadVolume. This module reads standardized VIRVO volume files, as well as sequences of 2D slice images. Volume files can be created by the module WriteVolume.

5.2.1 Module ReadVolume

Figure 5.3 shows a typical COVISE network to read a volume file and display it in the renderer. It accepts several volume data types, and it can load a series of 2D images and merge them to a volume dataset. Files types are distinguished exclusively by the suffixes of their file names.

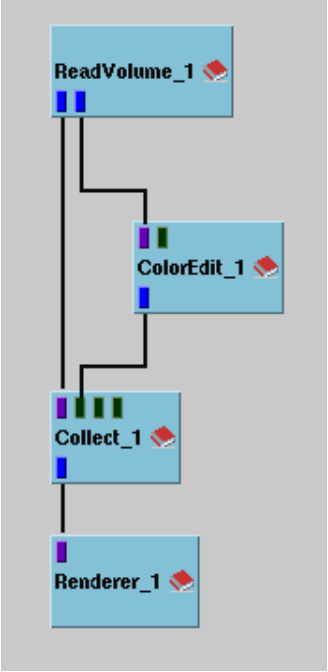


Figure 5.3: Map with ReadVolume to read volume datasets from disk

The following file types are supported by the module ReadVolume:

Figure 5.4 shows the ReadVolume Preferences window. The source file name must be set at the FilePath entry. If CustomSize is unchecked, the size entries are ignored and default values or the values from the respective volume file are used. Otherwise, the volume size will be set as entered in VolumeWidth, -Height, and -Depth.

ReadVolume can create a volume from a number of 2D slice images (RGB, PGM, or PPM files). To do so, the slice images have to be numbered ascendingly, for instance IMAGE001.RGB, IMAGE002.RGB, IMAGE003.RGB, etc. The first file name has to be entered as the source path in the ReadVolume

File Extension	Description
rvf	Raw Volume File
xvf	Extended Volume File
dat	Raw volume data (no header) - automatic format detection
pgm, ppm	Density or RGB images (depending on volume data type)

Preferences window. Then, on execution, the module loads all slice images and creates a volume dataset from them.

5.2.2 Module WriteVolume

Figure 5.5 shows an example COVISE network to write volume data from GenDat.

The following file types are supported by WriteVolume:

Figure 5.6 shows the preferences window of the module WriteVolume. The FileName entry expects the destination file name. If OverwriteExisting is checked, the destination file will be overwritten, if it previously existed. The file type and data format can be selected with the respective choice menus. MinimumValue und MaximumValue allow to constrain the stored data range. All values that are smaller or equal to MinimumValue will become zero, values greater or equal to MaximumValue will become 255 or 65535, depending on the data format (8 or 16 bit per voxel). The remaining values are distributed linearly inbetween.

5.3 Desktop Renderer

COVISE's desktop renderer displays volume data after they had been classified with the Color Editor module. A simple module layout can be created with the GenDat module (see Figure 5.7) as a uniform grid generator, when volume rendering compatible parameters (see Figure 5.8) are used. Both a uniform grid and scalar data are needed as data sources for volume data. The Color Editor (see Figure 5.9) acts as a transfer function editor. In order to get a volume display with semi-transparencies, the Transparency checkbox must be checked. The Color Editor module converts incoming scalar values to RGBA tuples, which are then passed on to the Collect module. The Collect module combines grid and data value information and feeds them into the renderer (see Figure 5.10).

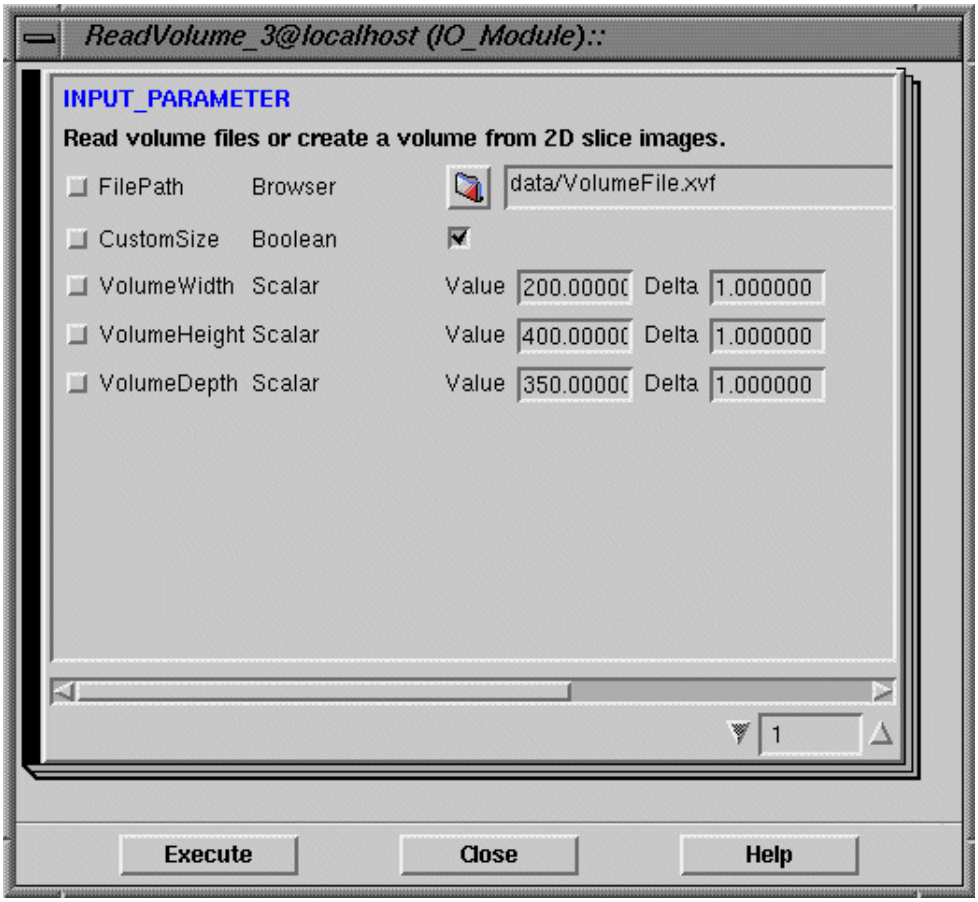


Figure 5.4: ReadVolume Preferences window

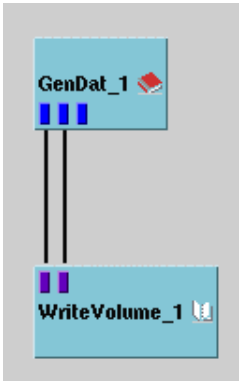


Figure 5.5: Map with WriteVolume to write volume datasets to disk

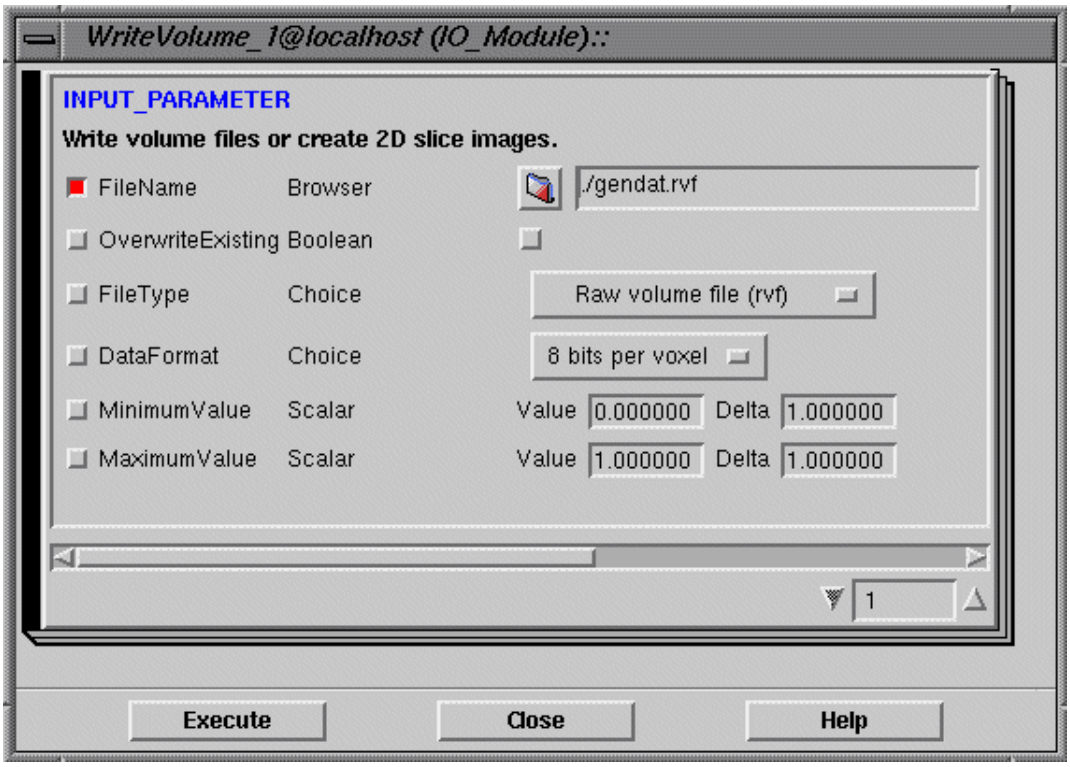


Figure 5.6: WriteVolume Preferences window

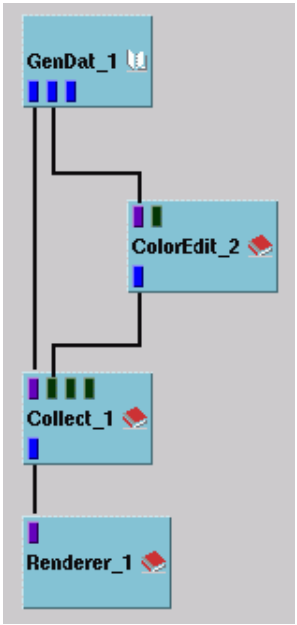


Figure 5.7: Simple volume rendering map with GenDat

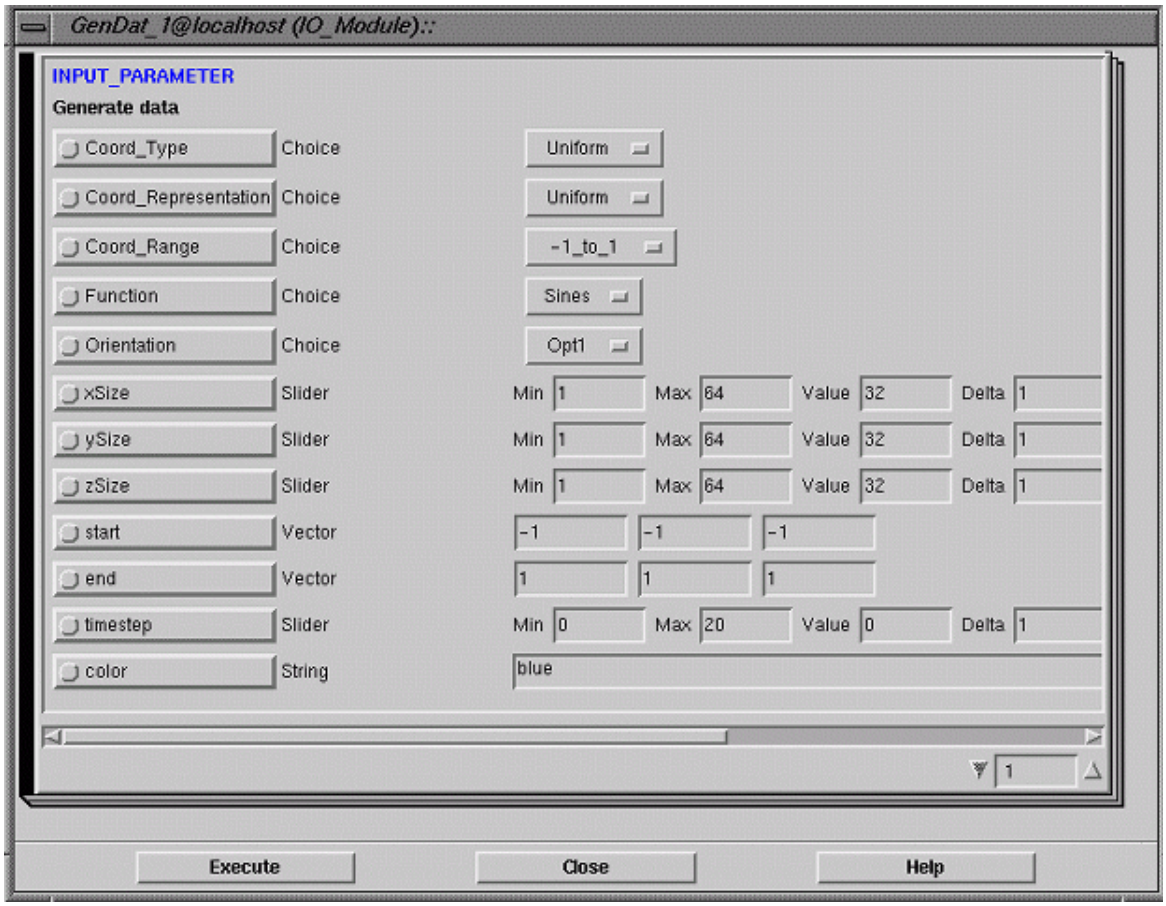


Figure 5.8: GenDat parameters suitable for volume rendering

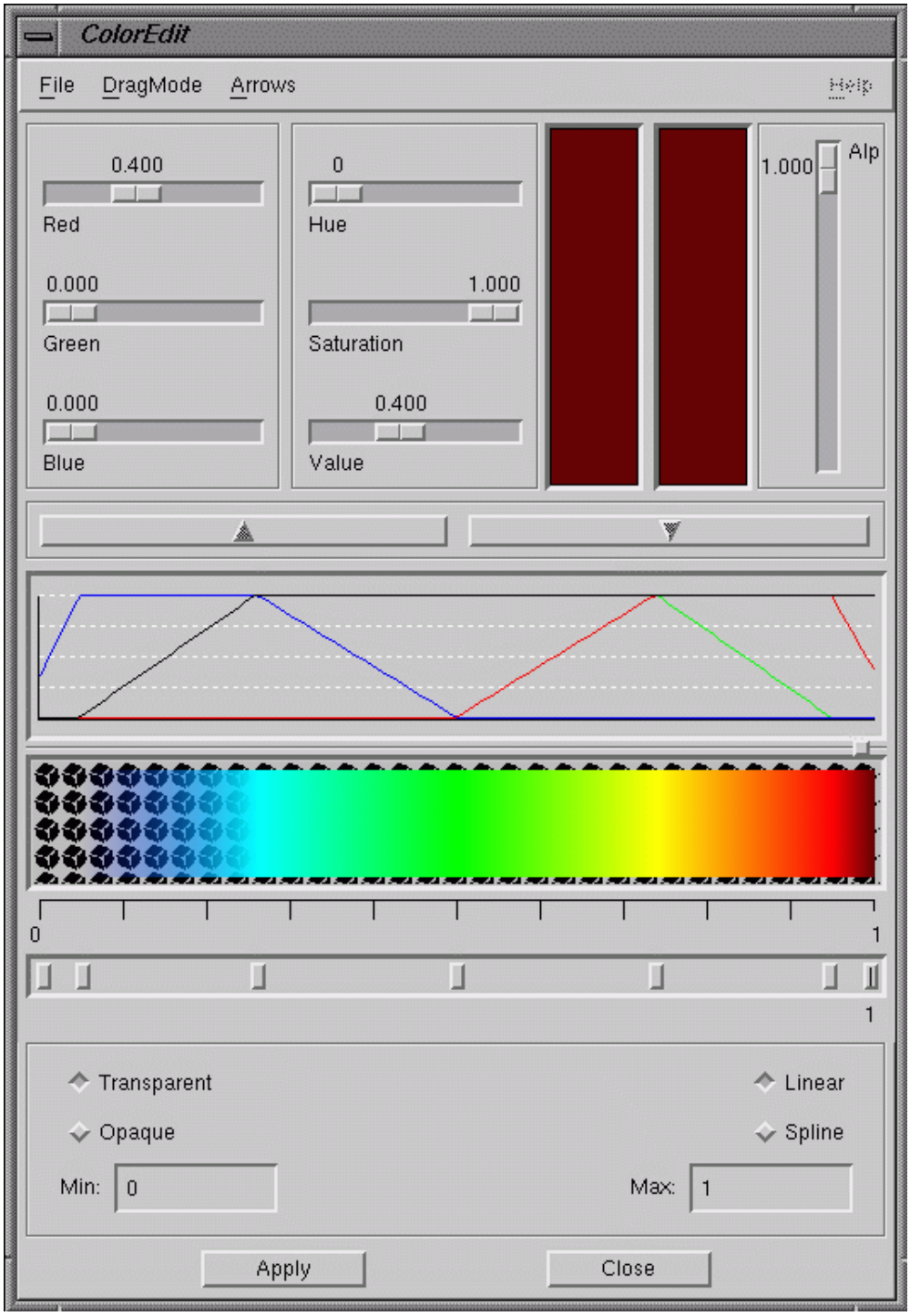


Figure 5.9: ColorEdit's color editor window

In the renderer window, the volume object is just another COVISE data object. If both volume data and traditional data are displayed, occlusion artifacts may occur. For this case, the renderer menu offers several types of transparency sorting.

The desktop renderer offers a special draw style for volume data: while the data is rotated with the mouse, the volume is drawn in a lower quality to speed up the drawing process, and when the mouse

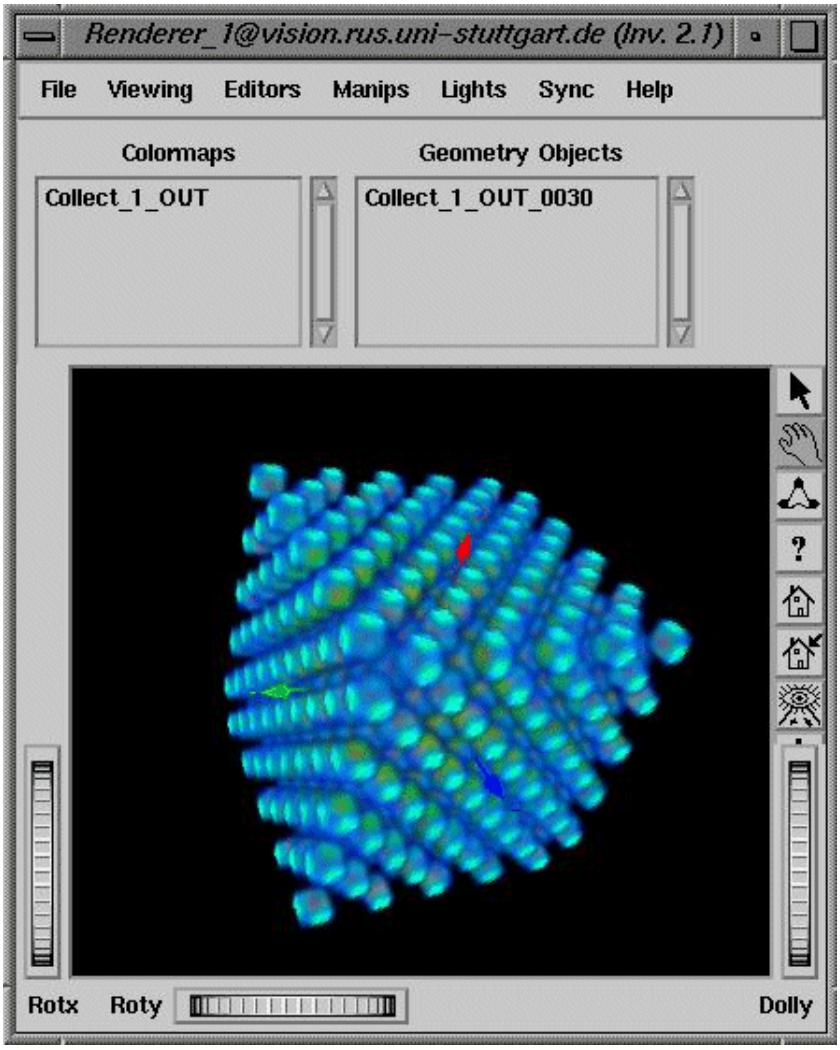


Figure 5.10: Volume rendering output of simple GenDat application

button is released, the volume is drawn in regular quality. This draw mode ("move low volume") can be enabled in the pop-up menu which appears when the right mouse button is pressed in the renderer window.

The quality of the static volume display can be set in the renderer's Preferences window (sampling rate, see encircled area in Figure 5.11). The Preferences window can be accessed from the renderer window's pop-up.

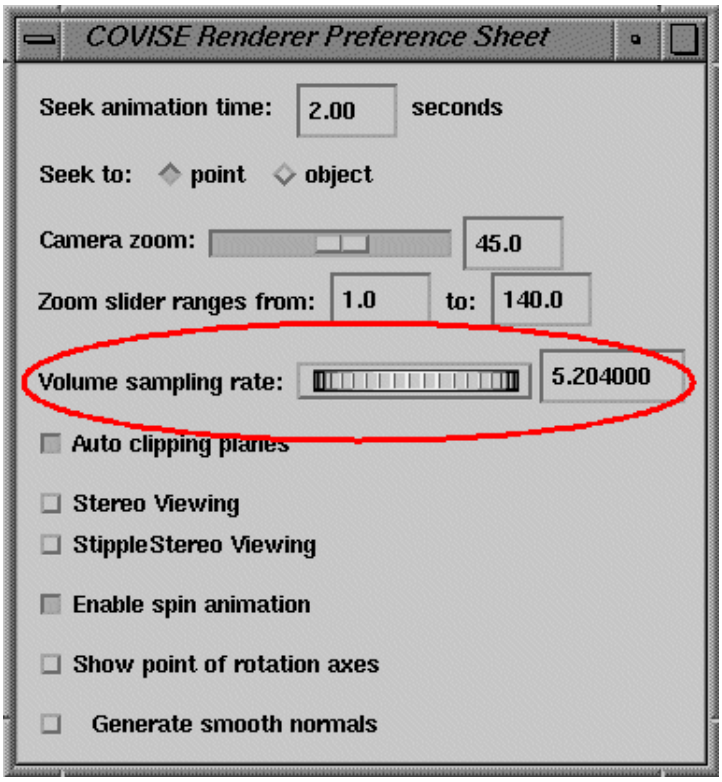


Figure 5.11: Desktop renderer's Preferences for volume quality

5.4 VR Renderer

In order to work with volume data in the VR renderer COVER, the volume plugin must be loaded by adding the following line to the COVERConfig section of the covise.config file:

```
MODULE VolumePlugin
```

COVER's volume rendering capabilities can be accessed by the Volume menu (see Figure 5.12), which appears in the COVER main menu (see Figure 5.13) when the volume plugin was successfully loaded at startup. Its topmost entry is Files, which opens another menu with a selection of volume files. The file selection can be defined in the covise.config file in the VolumeFiles scope. Each line represents a file entry, consisting of a file path and a display name. These files can be created with the COVISE module WriteVolume, the supported file types are the same as for ReadVolume.

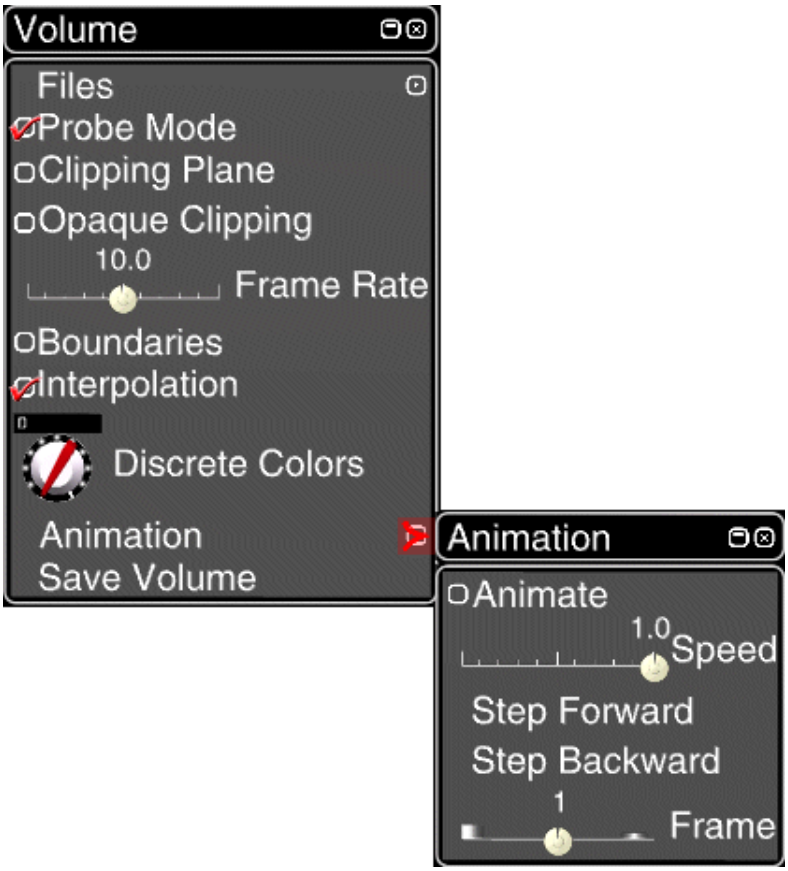


Figure 5.12: COVER Volume menu with Animation sub-menu

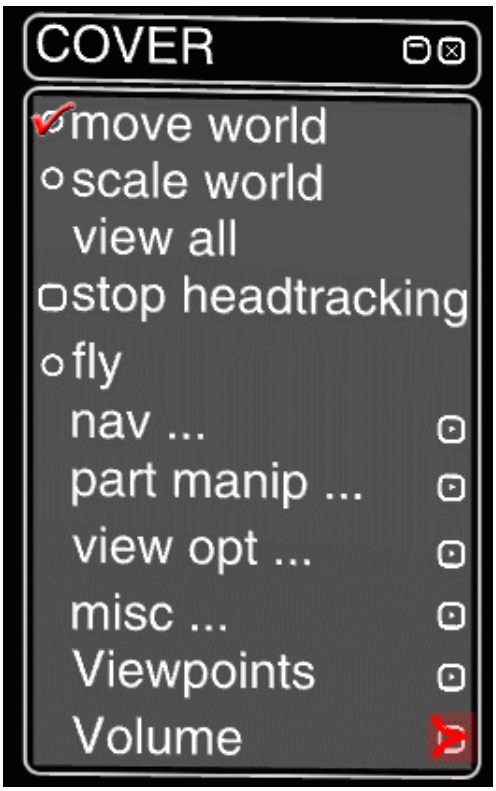


Figure 5.13: The COVER main menu

The Probe Mode checkbox toggles a mode in which only a cubic sub-volume is displayed (see Figure 5.16), which can be dragged around with the left mouse button and the size of which can be adjusted by twisting the mouse. Due to a smaller displayed region, a higher image quality is gained in the sub-volume.

A clipping plane can be enabled by the Clipping Plane entry. By default the plane clips off the data on one side of the plane (see Figure 5.14), but it displays an opaque plane at the clipping location if Opaque Clipping is enabled (see Figure 5.15). To move the clipping plane, it has to be turned off and on again. The Clipping Plane checkbox enables or disables both clipping plane modes, the Opaque Clipping checkbox defines only the clipping type used.

With the Frame Rate slider, the Volume menu allows to set the rendering speed, which in turn affects display quality.

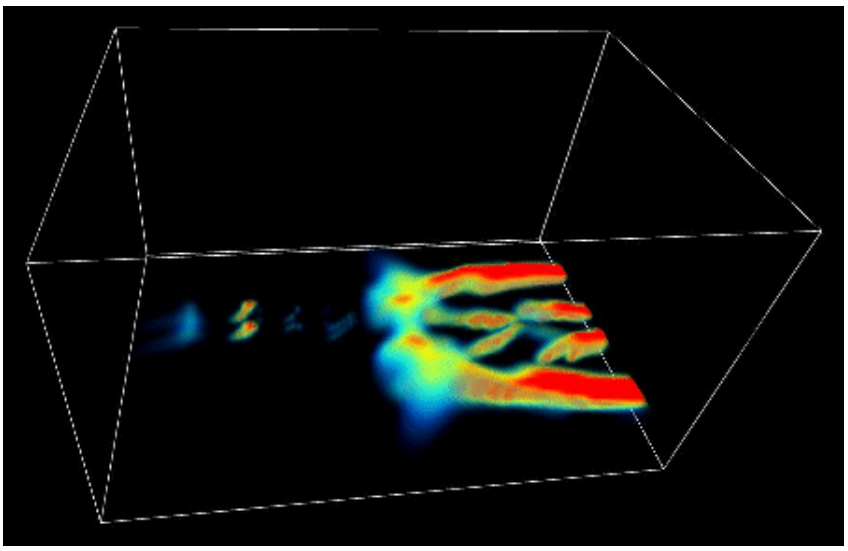


Figure 5.14: Lambda dataset with clipping plane

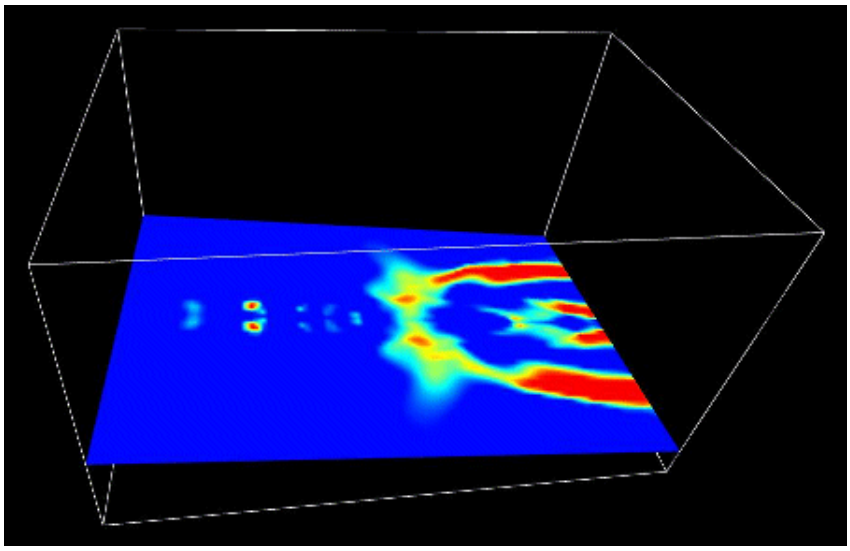


Figure 5.15: Lambda dataset with opaque clipping plane

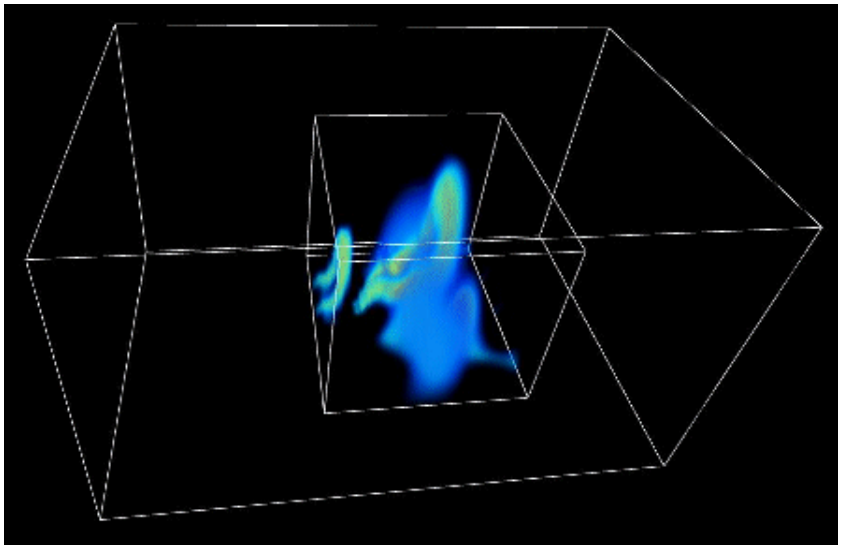


Figure 5.16: Lambda dataset in probe mode

Another menu entry toggles a boundary box (see Figure 5.17) around the dataset. Yet another entry toggles data value interpolation (see Figure 5.18). By default, three-linear interpolation is used (if supported by the graphics hardware), when the interpolation is off, nearest neighbor interpolation is used for the volume display.

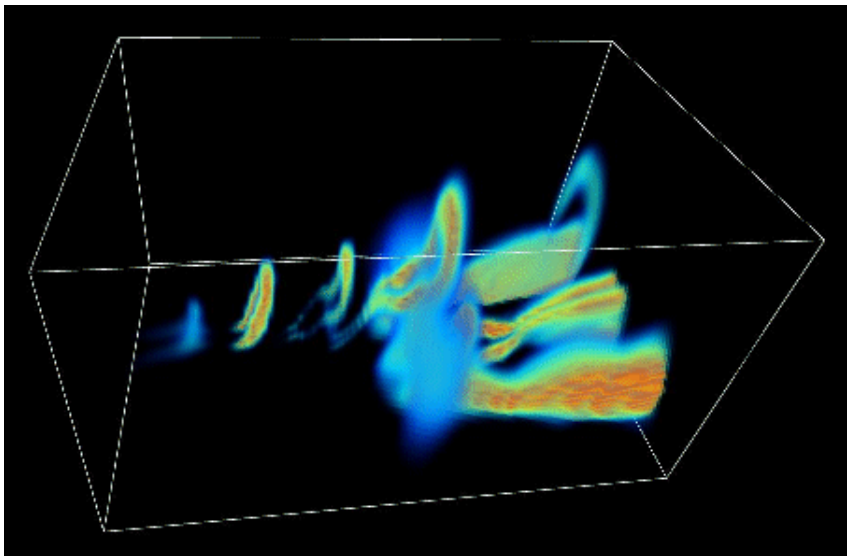


Figure 5.17: Lambda dataset with wireframe boundary box

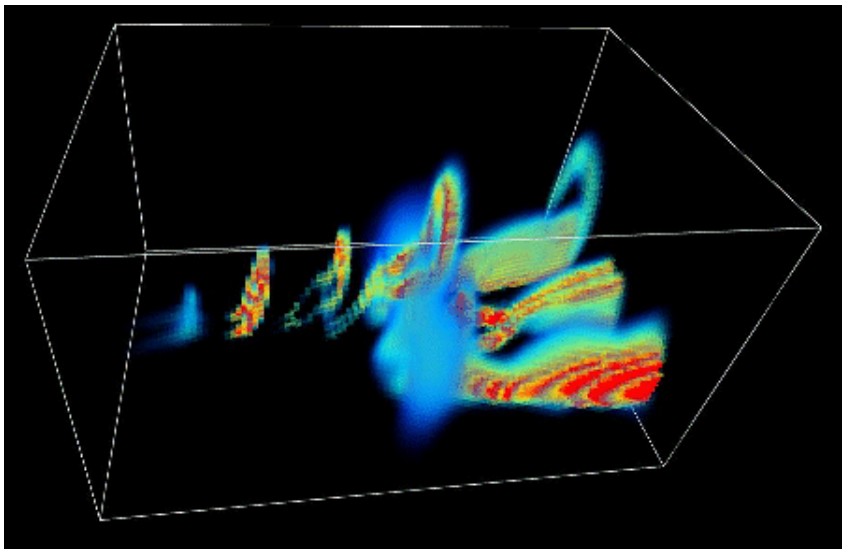


Figure 5.18: Lambda dataset without trilinear interpolation

When the Discrete Colors knob is set to zero, the Discrete Colors mode is turned off, and continuous color gradients are used for the transfer function. If the knob is set to a non-zero value, only as many different colors are used for the color transfer function as selected.

The Animation menu can be used to control the display of time dependent datasets. If only a single time step is loaded, this menu has no effect. When Animate is checked, the time steps are cycled at the value selected by Speed. When the Speed slider is in the middle of its range, the speed is zero. The animation runs backwards if the slider is in the left half of its range. Step Forward and Backward

can be used to switch to the next or previous time step respectively. The Frame slider can be used to directly access a specific time step.

When the Save Volume menu item is clicked on, the currently loaded volume dataset, together with the current transfer function, is stored to the file "virvo-saved.xvf", which is located in the directory which was current when COVER was started. The file can be read with ReadVolume, but only without the transfer function. When it is loaded directly from COVER's Volume Plugin by entering it into the list of files for the Files menu entry (in covise.config), the saved transfer function will be restored.

As soon as a volume is loaded from the menu, the transfer function editor window pops up (see Figure 5.19). The transfer function for opacity can be combined by a number of different elements: a tent function, a ramp, and an alpha blank. In the transfer function window, the elements can be accessed by Pins, which are represented as vertical lines. These lines can be moved horizontally. For each scalar value, the maximum value of the alpha function's components define the current transfer function. Alpha blanks dominate over all other alpha Pins, they set the alpha value to transparency no matter what other elements are located at the same position.

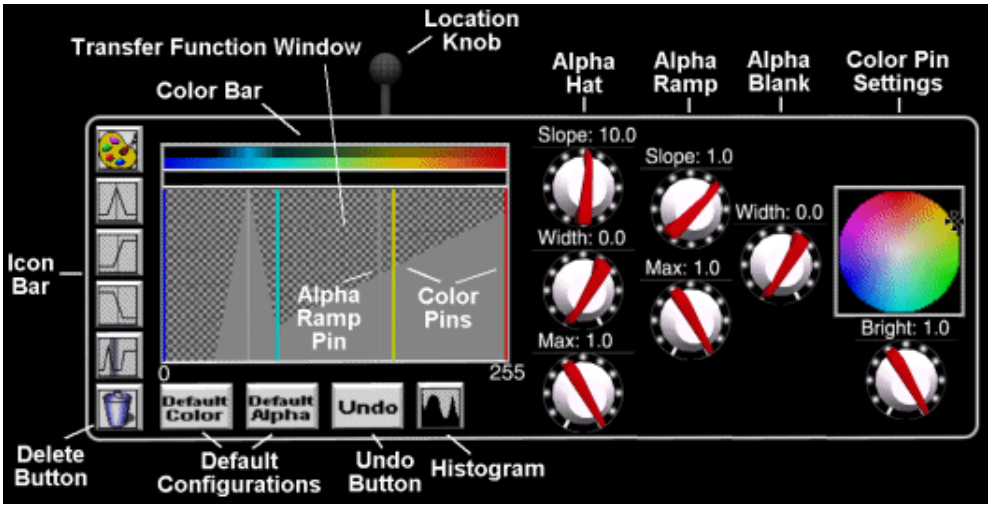


Figure 5.19: Transfer function editor in three different interaction states

Since in some cases the volume data display in virtual environments may be poor (see Figure 5.20) due to large image sizes, stereo projection and multiple screens, a high quality rendering mode (see Figure 5.21) was implemented. The user can switch to that display mode by clicking a mouse button while the mouse is located above the user's head. Then the volume is displayed with full detail, but the frame rate usually drops. No interaction with menus is possible, until the user leaves this mode with another mouse click at an arbitrary position.

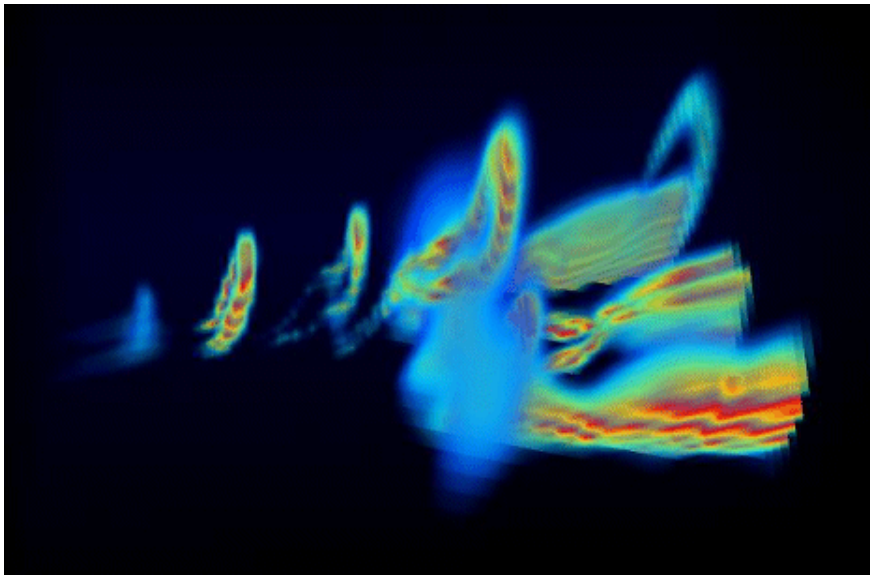


Figure 5.20: Low quality Lambda dataset

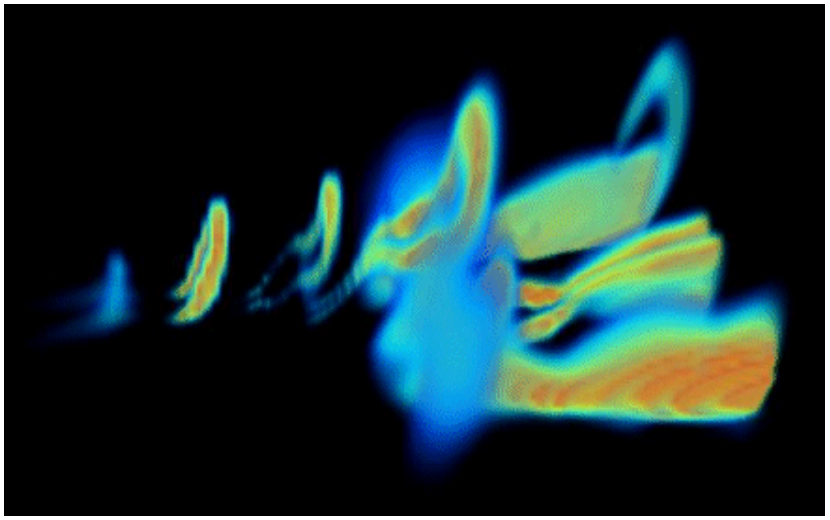


Figure 5.21: High quality Lambda dataset

5.5 Volume file types

DAT: Pure volume data file

This file type stores raw volume data without a header. The data can contain 1,2,3, or 4 byte per voxel. When loading a file of this type, the program tries to find the volume dimensions automatically. If this doesn't work, you can help by adding the volume size to the file name prefix, for instance "cthead256x256x64.dat" for a 256 x 256 x 64 voxels dataset.

The order of voxels in the file is: start at top-left-front, go right first, then down, then back (just like the order of letters in a book). All bytes of each voxel are stored consecutively, beginning with the most significant byte for 8 and 16 bit per voxel files, or in RGB(A) order for 24 and 32 bit per voxel files. DAT files can only store one time step.

RVF: Raw volume file

This format can easily be created by hand from any voxel data array on disk by adding the appropriate header: 3 x 2 Bytes (big endian) for the volume's width, height, and depth in voxels. This can be done with a hex editor, for example. The header of a 256x128x127 volume would be (hex values): 01 00 00 80 00 7F The volume data can only have 8 bit per voxel in RVF files, and only one time step can be stored. The data order is the same as in DAT files.

XVF: Extended volume file

This format can store more information than DAT and RVF, but it is still easy enough to describe and to create manually. XVF files can store multiple volume datasets (time steps) in one file, and the storage of a random number of transfer functions. 8 to 32 bit can be stored per voxel. In order to create an XVF file manually, it is important to know that the byte order of integer values is big endian (most significant first), floating point values are stored in big endian mode and 4 byte IEEE standard. In this standard, the hexadecimal representation of 1.0 is: 3F 80 00 00. Here is the XVF header specification:

XVF Header:

Length	Data Type	Description
9 bytes	char	file ID string: "VIRVO-XVF"
2 bytes	unsigned short	offset to beginning of data area, from top of file [bytes]
2 x 4 bytes	unsigned int	width and height of volume [voxels]
4 bytes	unsigned int	number of slices per time step
4 bytes	unsigned int	number of frames in volume animation (time steps)
1 byte	unsigned char	bits per voxel (supported values: 8, 16, 24, 32)
3 x 4 bytes	float	real world voxel size (width, height, depth) [mm]
4 bytes	float	length of a time step in the volume animation [seconds]
2 x 4 bytes	float	physical data range covered by voxel data (minimum, maximum)
3 x 4 bytes	float	real world location of volume center (x,y,z) [mm]
1 byte	unsigned char	compression type (0=none, not supported yet)
2 bytes	unsigned short	number of transfer functions
2 bytes	unsigned short	type of transfer functions: 0 = 4 x 256 Byte for RGBA channels (deprecated) 1 = list of control pins

Data area:

The data starts at the position "offset to beginning of data area" (see table). The voxel order is similar to DAT and RVF files, all bytes of each voxel are stored consecutively. If multiple time steps are stored, they follow one by one, with no separator inbetween.

Transfer functions:

The transfer functions are stored at the end of the file, right after the data area. Transfer functions

should not be added to the file manually, this should only be done from within COVISE (currently this is only supported by the "save volume" function in COVER). Therefore, the format of transfer functions will not be described here. To create a volume file manually, it is sufficient to set the number of transfer functions to zero in the header.

AVF: ASCII volume file

AVF files are ASCII representations of volume data. They consist of a header and a data section:

Header:

In the header, several lines give information about the data format. Each line consists of an identifier and a value, separated by whitespace. Each line can contain one identifier and one value. This file format cannot store transfer functions. Anywhere in the file, comments starting with '#' are allowed. This comments out all the rest of the line.

The following abbreviations are used:

```
<int> = integer values
<float> = floating point values
<OPT1|OPT2|OPT3> = list of options
```

The following lines are required:

WIDTH [int]	width of the volume [voxels]
HEIGHT [int]	height of the volume [voxels]
SLICES [int]	number of slices in the volume [voxels]

The following lines are optional. If they are missing, the respective default values are used:

FRAMES [int]	number of data sets contained in the file (default: 1)
MIN [float]	minimum data value, smaller values are constrained to this value (default: 0.0)
MAX [float]	maximum data value, larger values are constrained to this value (default: 1.0)
FORMAT [SCALAR8/16 or RGB(A)]	voxel data format (default: SCALAR8): SCALAR8 = scalar values, to be stored as 8 bit integers SCALAR16 = scalar values, to be stored as 16 bit integers RGB = color values, consisting of a red, a green, and a blue color component, stored as 3x8 bit RGBA = color values, consisting of a red, a green, a blue, and an opacity (alpha) value, stored as 4x8 bit
XDIST [float]	the sample distance in x direction (width) [mm] (default: 1.0)
YDIST [float]	the sample distance in y direction (height) [mm] (default: 1.0)
ZDIST [float]	the sample distance in z direction (slices) [mm] (default: 1.0)
TIME [float]	the length of each time step for transient data [s] (default: 1.0)

Data area:

The data area begins right after the header. The voxel data values are listed, separated by whitespace and/or end-of-line markers. Both floating point and integer values are accepted. The voxel order is similar to DAT, RVF, and XVF files. All elements of each voxel are stored consecutively.

Sample file:

```
WIDTH 4
HEIGHT 3
SLICES 2
```

```
FRAMES 1
MIN 0.0
MAX 1.0
FORMAT SCALAR8 # 8 bit data
XDIST 1.0
YDIST 1.0
ZDIST 1.0
TIME 1.0
0.9 0.9 0.9 0.9
0.9 0.2 0.3 0.9
0.9 0.2 0.4 0.9
0.8 0.8 0.8 0.8
0.8 0.1 0.1 0.8
0.8 0.0 0.0 0.8
```

5.6 Acknowledgments

The lambda function dataset used in some images is courtesy of Ulrich Rist, IAG, University of Stuttgart.

6 COVISE CE (Collaborative Engineering)

6.1 Architecture and Configuration

6.1.1 Architecture Summary

Usage Hints:

This short introduction has been prepared for users with basic experience in using COVISE VR in a standalone environment only; for this user group it provides the necessary background to extend the use of COVISE to Collaborative Engineering, i.e. COVISE CE. The information has been collected from the Tutorial, the first chapters of the (old) User's Guide, and other sources to provide one reference chapter for these users.

For collaborative working you can either use COVISE CE alone - as described in this document - or you can extend a collaborative COVISE session to a complete (virtual) meeting, using **N'S^3(COVISE Conference Room Interface)**. The Conference Room Interface (optional feature, described in a separate document)

- has been developed in the framework of the N'S^3(ENScube) project.
- is based on Sametime (Sametime is a trademark of IBM Lotus Corporation)

Architectural Concepts:

For collaborative working with COVISE you should know the basic architectural concepts of COVISE. After having read this chapter you will be familiar with:

- The Architecture of COVISE
- how to prepare COVISE for a distributed or collaborative session

In COVISE it is possible to run modules on remote computers. This is also known as "Distributed Computing". By distributing modules across a network one can make use of remote resources for example of a compute server with more CPUs or memory than on a local workstation or PC. The COVISE session is controlled from the Mapeditor on the local workstation. Remote hosts are included in the session via the menu item CSCW >> AddHost (CSCW = Computer Supported Collaborative Work).

In a multiuser session each participant has his own Mapeditor and Renderer. The session has to be initiated by one partner who adds the other partners to the session (menu item CSCW >> AddPartner). The initiating partner plays the master role, which means that he has the control over the Mapeditor and the Renderer. If he e.g. changes the camera position in the Renderer all other partner's cameras are synchronised with the master camera. The master role can be exchanged between partners. This way of working together in a multiuser session is also known as "Collaborative Working" or - for COVISE applications - as "Collaborative Engineering" where COVISE is regarded as a "Shared Application" which is aware of the sharing.

As the hosts of the partners can also be used for distributed computing COVISE extends far beyond a "Shared Application" such as the ones based on X Windows sharing or a Windows application shared via Netmeeting.

The next sections provide background information on the COVISE architecture and explain how a distributed session (Distributed Computing) or a collaborative session (for Collaborative Engineering) is implemented.

See also: Additional feature COVISE daemon "covised":
The COVISE daemon "covised" - included as a **preversion** in Rel. 5.2 - provides a more general and more comfortable user interface for collaborative working than CSCW, using a concept of "rooms" (working groups - can be **predefined**) like N'S (see **5.6 New Collaborative COVISE**)

6.1.2 Distributed Computing

In **COVISE** it is possible to run modules on remote computers. This is also known as *Distributed Computing*. By distributing modules across a network remote resources are used for example of a compute server with more CPUs or memory than o¡Zwischenablage leer¿n your local workstation or PC. The **COVISE** session is controlled from the **MapEditor** on the local workstation.

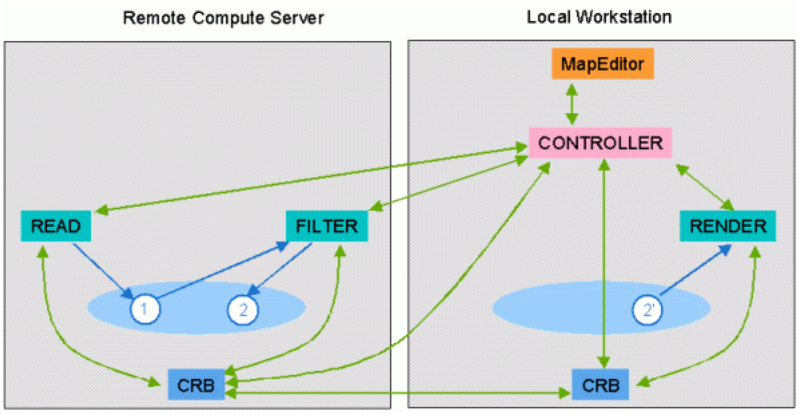


Figure 6.1: Distributed Session (Distributed Computing)

The previous figure shows the elements of an example for distributed working in **COVISE**. The application consists of three modules: a module which reads in data (READ) a module which extracts a special feature (FILTER) and a module which displays the extracted data (RENDER). As the filter module consumes much CPU time and memory it will be started on a remote compute server, also the Reader because the data to be read in is on the remote machine. The first process started by **COVISE** is the **Controller** which in turn starts the user interface process **MapEditor** and the data management process **CRB**. As soon as another host is included in the session a **CRB** is started on that computer. The read module is started on the local workstation, the filter module on the remote computer and the renderer on the local workstation. The green arrows between the processes **Controller**, **MapEditor**, **CRB** and the modules indicate TCP sockets, the blue arrows indicate shared memory access.

When the module map is executed the **Controller** sends a start message to the remote read module. The read module reads in the data file and creates a **COVISE** data object (1) in shared memory and after processing tells the **Controller** that the module has finished. The **Controller** informs the filter module on the remote computer to start. The filter module asks its data management process (**CRB**) for the data object (1). The filter module now reads that data object, computes something and puts the data object (2) into shared memory. It then tells the **Controller** that it has finished. The **Controller** informs the renderer module to start. The renderer asks the **CRB** for object (2) and as this object is not available on the local workstations the **CRB** transfers it from the compute server into the shared memory of the local workstation (2'). Now the renderer can access this object and display the data.

6.1.3 Collaborative Working

In a multiuser session each participant has it's own **MapEditor** and **Renderer**. The session has to be initiated by one partner who adds the other partners to the session. The initiating partner plays the master role, which means that he has the control over the **MapEditor** and the **Renderer**. If he e.g. changes the camera position in the **Renderer** all other partner's cameras are synchronised with the master camera. The master role can be exchanged between partners. This way of working together in a multiuser session is also known as *Collaborative Working / Collaborative Engineering*. The hosts of the partners can also be used for distributed computing.

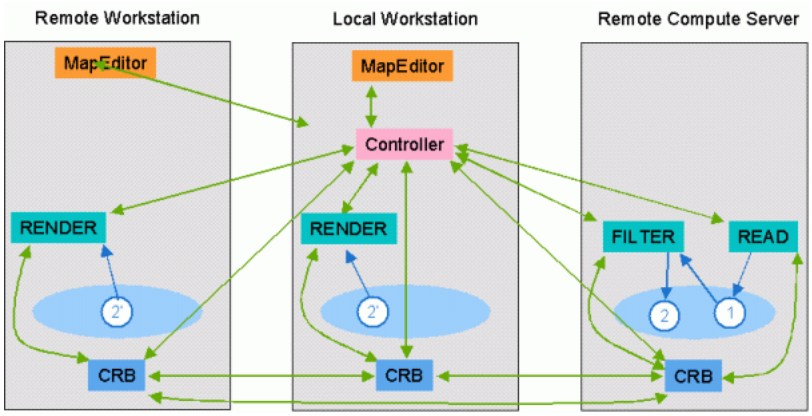


Figure 6.2: Collaborative Session (Collaborative Engineering in COVISE CE)

In a collaborative session (see figure) a user interface process (**MapEditor**) and a **Renderer** are started also on the remote machine. The **Renderer** module is the only module which is started on all computers in a session.

6.1.4 Preparing COVISE for a Distributed or a Collaborative Session

See also: Additional feature COVISE daemon "covised":
The COVISE daemon "covised" - included as a **preversion** in Rel. 5.2 - provides a more general and more comfortable user interface for collaborative working than CSCW, using a concept of "rooms" (working groups - can be **predefined**) like N'S (see **5.6 New Collaborative COVISE**)

Every computer that will participate in a distributed or collaborative session should be included in the section HostConfig in the file covise.config. For each host you have to specify the memory model for data exchange between modules on the local machine, the execution mode and a timeout for TCP connections.

```
HostConfig
{
    # Hostname MemoryModel ExecutionMode Timeout
    vista       shm         rexec         30
    visit       shm         rexec         30
}
```

For workstations and PCs the memory model is shm which stands for shared memory. There are other memory models like none specifically for machines such as CRAY Y-MP computers.

The execution mode specifies the command which should be used to start the CRB on the remote computer. Possible execution modes are:

- rexec
- rsh
- ssh
- nqs
- manual

For all execution modes besides manual one needs access to the account on the remote computer. For rexec one has to enter the hostname, the user id and the password on the remote machine (similar to logging in on the remote computer using telnet). rsh and ssh can only be used if they allow to log in without password specification (see man rsh and ssh for the files where allowed users are specified). nqs is not recommended, it can be used to put the CRB into a batch queue. Manual means that one has to start the CRB process manually on the remote machine. This can be useful for sessions across a firewall or if one doesn't have access to the remote account. In this case COVISE shows a command in the window where COVISE was started.

The time-out value specifies how many seconds a process will wait to be contacted by a new process that he initiated (e.g. the Controller waiting for a module). The default value is 5 seconds. For slow networks a time-out of 30 seconds is useful. For very slow networks even a higher value is recommended.

6.1.5 COVISE across Firewalls

As shown in Figure 5.2 COVISE uses TCP sockets for communication with remote hosts. A socket is defined by an IP address, a port number and the protocol (here tcp). COVISE port numbers start by default at 31000. One can configure the start number in the file covise.config using the keyword COVISE_PORT in the section network:

```
Network
{
    COVISE_PORT     5000
}
```

For collaborative or distributed sessions across firewalls the firewall has to allow tcp connections to ports in both directions starting with the number defined in covise.config. You need as many ports as modules started during the whole session +3 for distributed sessions or + 4 for collaborative sessions (if you load several maps in a session each map needs new ports). Depending on the execution mode the ports for rexec, rsh or ssh have to be allowed. For the execution mode manual no extra port is required.

Note:

If you use IP forwarding from your firewall to your local computer you have to make additional configurations. Every host that wants to connect to your session has to know that you are behind a firewall and use IP forwarding. Therefore you can tell COVISE not to connect to your machine but to your firewall instead. This is done by adding an IP_ALIAS entry on every client side. Assume your IP is 192.168.0.15 and your firewall has the IP 133.168.226.234 from the outside. Then you have to add

```
Network {
   IP_ALIAS    192.168.0.15    133.168.226.234
   #           <your IP>       <your firewall IP> =

}
```

to the config file on every host you want to connect to.

6.2 CSCW

6.2.1 CSCW Summary

After having read this section you will be familiar with:

- including a remote host or partner in the session
- starting a module on the remote computer

See also: Additional feature COVISE daemon "covised":
The COVISE daemon "covised" - included as a **preversion** in Rel. 5.2 - provides a more general and more comfortable user interface for collaborative working than CSCW, using a concept of "rooms" (working groups - can be **predefined**) like N'S (see **5.6 New Collaborative COVISE**)

Notes:

- It is strongly recommended to use COVISE version 5.2 (or higher) on all participating hosts. Otherwise you may have different sets of options and you may run into compatibility problems (e.g. with changes in the implementation of data types).
- Set Mirrors etc: see Section 4, Mirroring
- Open Conference Room: By using the COVISE Conference Room Interface (optional feature,

based on Sametime - Sametime is a trademark of IBM Lotus Corporation) you can extend a Collaborative COVISE Session to a complete meeting - see COVISE Conference Room Interface (separate document).

6.2.2 Including a remote host or partner in the session

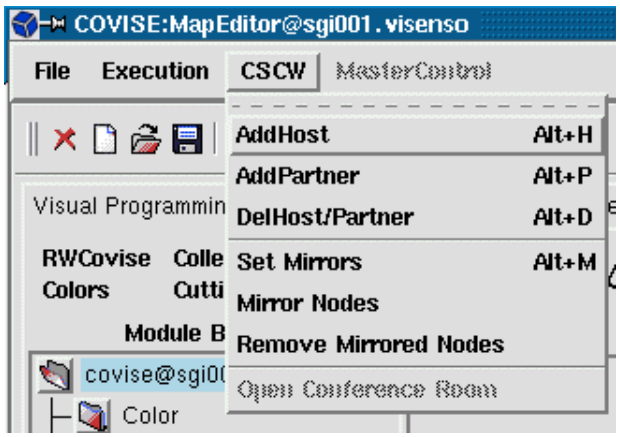


Figure 6.3: Hosts(CSCW) Menu

Figure 5.3 shows the menu item for adding a remote host or including a new partner into the session (CSCW = Computer Supported Collaborative Work).

The window in Figure 5.4 will pop up. First select a hostname or enter a new one. .gif If the selected hostname is available, the window in Figure 5.5 will appear. You can select the parameters for a connection.

Depending on the configuration parameters in *covise.config* the execution model and the time-out are adjusted. Now one can change the time-out and the execution mode if other values than the standard are required.

For execution mode rexec the user id and password on the remote computer has to be entered. For execution mode rsh or ssh only the user id is needed

In the manual execution mode COVISE writes a message in the window saying how COVISE should be started on the remote computer. It looks like

```
start "crb 31005 129.69.29.12 1005" on
visit.rus.uni-stuttgart.de
```

The collaboration partner has to type in the following command (which has to be provided to him by means such as phone, video conference or email):

```
crb 31005 129.69.29.12 1005
```

When the remote host is successfully added, the remote username and hostname will appear in the list of hostnames of the **Module Browser**. Depending on the specification in the scope *UIConfig* of the config.file , the new host and his modules are shown either in another color or have the hostname in their label. Here the option is used that hosts are shown colored(see Figure 2.4). When the remote computer is added successfully the remote username and hostname will appear in the module browser list (see Figure 2.4). Here the option is used that hosts are shown colored.

In a multiuser session (CSCW >> AddPartner) a Mapeditor will pop up on the remote workstation.

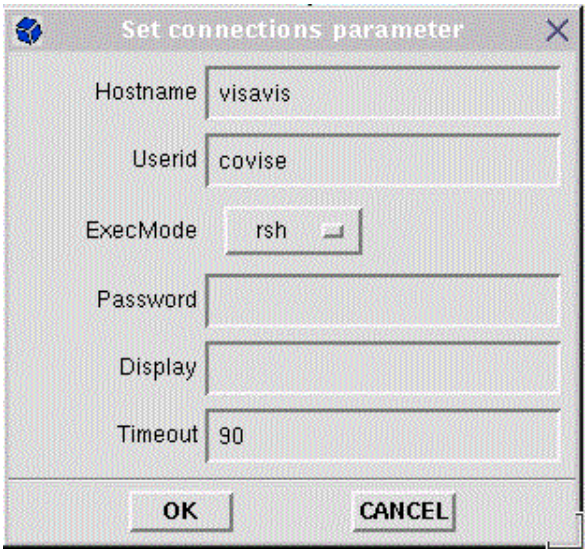


Figure 6.4: Set Connection Parameters

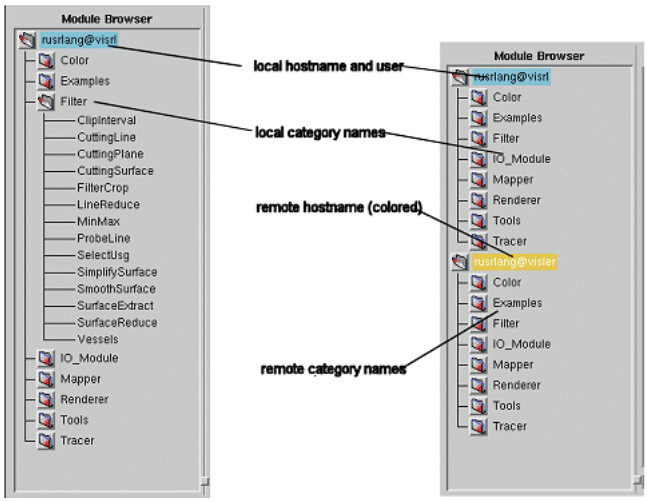


Figure 6.5: Module Browser Windows for Local and Distributed/Collaborative Working

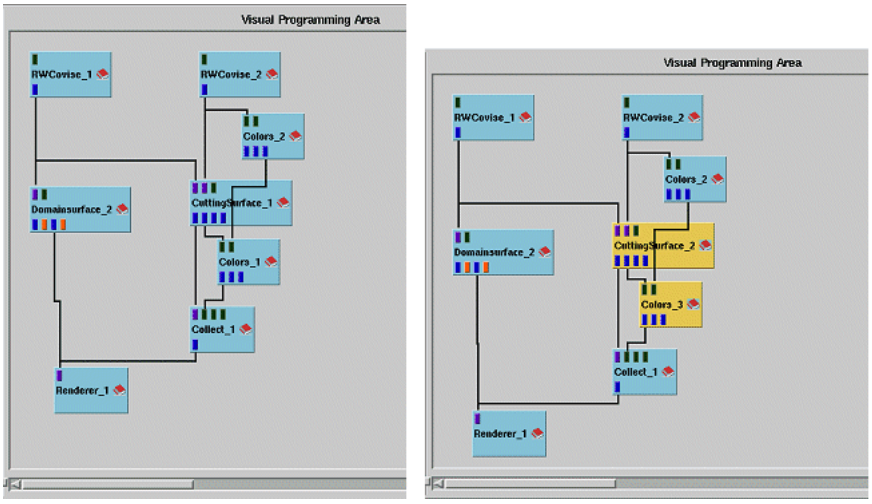


Figure 6.6: Module Map for Local and Distributed/Collaborative Working

6.2.3 Starting a module on the remote computer

When selecting the remote computer in the hosts list the categories and modules available on this computer will be offered. Clicking on a module it is started on the remote computer. This is indicated by the hostname in front of the module name (Figure 2.5), if the hosts are not colored.

Figure 6.7: Icon for a Remote Module

Next the module ports have to be connected and parameters adjusted. It does not make any difference whether modules are executed locally or on a remote computer.

When a map is saved (menu File >> Save) the information about the hostname is saved, too. When a map is loaded which was saved including remote modules one is asked to add the remote hosts first

6.3 MasterCtrl

6.3.1 MasterCtrl Summary

After having read this chapter you will be familiar with:

- sending a Master Request (using MasterCtrl in the MapEditor or the Renderer PopUp Menu)
- synchronization of Renderers
- using the Telepointer
- using the Chat Line

6.3.2 Master Request

CSCW >> AddPartner includes the remote host in the session and starts a Mapeditor on the remote machine. Except for the renderers all other modules are started on the computer which was selected in the hosts list. Renderer modules are started on all workstations.

The partner who initiated the session initially has the master role. He can load maps or start modules and connect them. He also controls the renderers. The slave partners can watch all actions of the master but all menu items besides the menu master and interaction in the Mapeditor are deactivated. This is indicated by grey text on the menu buttons and in the modules. The slave partners can request the master role using the menu MasterControl >> Request (or use the corresponing item "MasterRequest" of the Viewer Popup Menu in the Renderer). Fig. 5.9 and 5.10 below show both possibilities.

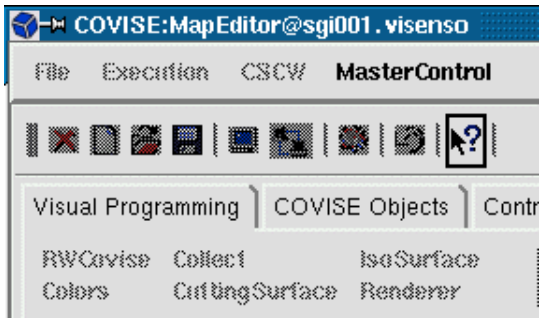


Figure 6.8: MasterControl from Mapeditor

Figure 6.9: MasterRequest from Renderer

If you click on MasterCtrl, a question dialog (Figure 5.11) pops up on the master computer:

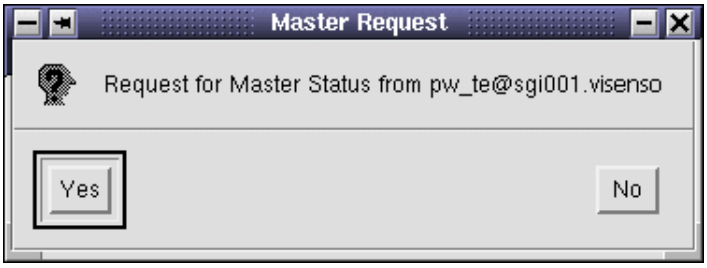


Figure 6.10: Master Request Window

If the master replies **No** you will be informed by the window shown in Fig. 5.12

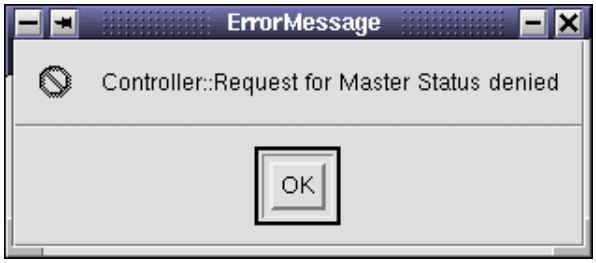


Figure 6.11: Negative Response

If the master replies **Yes**

- all previously grey menu items on the former slave side are now black (selectable), only MasterCtrl becomes grey (not selectable)
- all previously black menu items on the master side are now grey (not selectable), only MasterCtrl becomes black (selectable)

This applies not only to the Mapeditor menu but also to the parameter entries in Module Info and Control Panel window - but please note the following **restrictions for scalar/slider parameters** if their appearance type has been changed to "player"/"sequencer":

- A player/sequencer will be stopped if you transfer control to the slave
- the "delta value" is will not be transferred to the slave; so if you don't like the default value you have to explicitly set delta at the slave.

6.3.3 Synchronization

The slave Renderers are synchronised with the master renderer which means that all manipulation actions like changing the camera position, zooming, selecting objects etc. are sent to the slave Renderers. As long as the master doesn't do anything in the Renderer the slave Renderers can be used independently.

Depending on the line speed of your connection, you can choose your adequate level of synchronization (see Fig. 5.13); use LOOSE coupling if you have a slow connection.

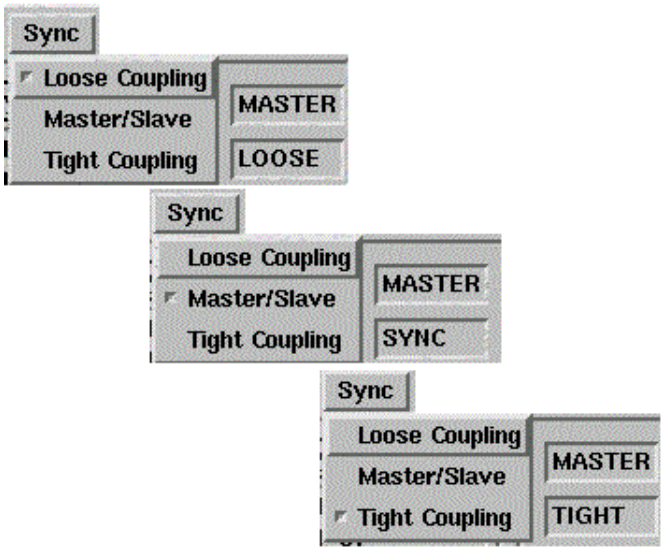


Figure 6.12: Increasing levels of Synchronization

This is a summary of the different levels of coupling:

- **Master/Slave Coupling - Sync Field=SYNC (default value):** Normally a master/slave relationship has been established between the partners of a working session. Only the master can change e. g. the camera position in his renderer, and the cameras of all other partners are synchronized with the master camera. In general, manipulators and editors become detached and invisible, the menu bar is set to insensitive in the slave renderers, and the scene in all slave renderers is updated according to the view in the master renderer. (Exception: Light information is not sent to other renderers in a cooperative environment) The Sync field of the information area is set to **SYNC**.
- **Tight Coupling - Sync Field=TIGHT:** The only difference between TIGHT and Master/Slave (SYNC) is that TIGHT enforces permanent synchronization whereas Master/Slave updates the slave renderers at endpoints only. The Sync field of the information area is set to **TIGHT**.
- **Loose Coupling - Sync Field=LOOSE:** If the master enables this mode all partners have the same interaction facilities as the master; the camera positions etc. are no longer sent to other renderers. The Sync field of the information area is set to **LOOSE**.

6.3.4 Telepointer

One can make his own mouse pointer visible for the partners by pressing the SHIFT key and moving the mouse. This functionality is called Telepointer. In all remote renderers the originating hostname appears at the position pointed at (Figure 3.5). This also works for Renderer windows having different sizes as the position in 3D space is transmitted and not the 2D pixel coordinates.

Figure 5.14 shows a snapshot from a collaborative session. The user pw_te on host richard.visenso.de uses the telepointer to show the other user(s) the backflow zone in a channel.

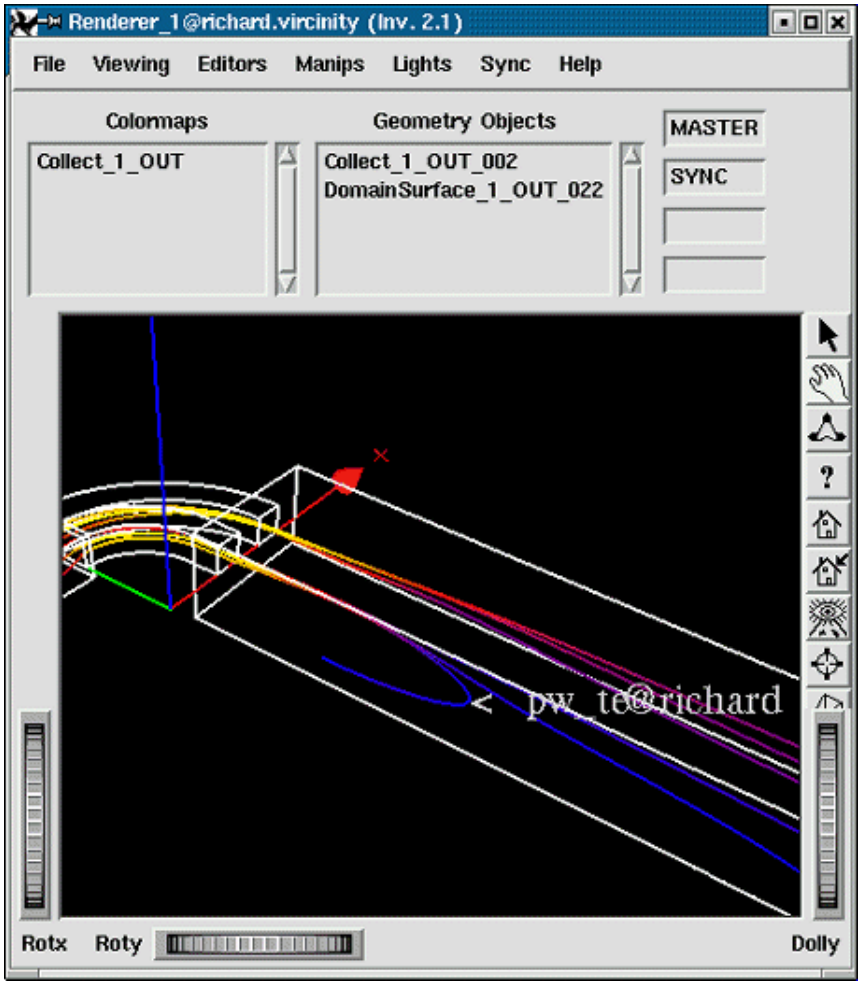


Figure 6.13: Telepointer in the Renderer

6.3.5 Chat Line

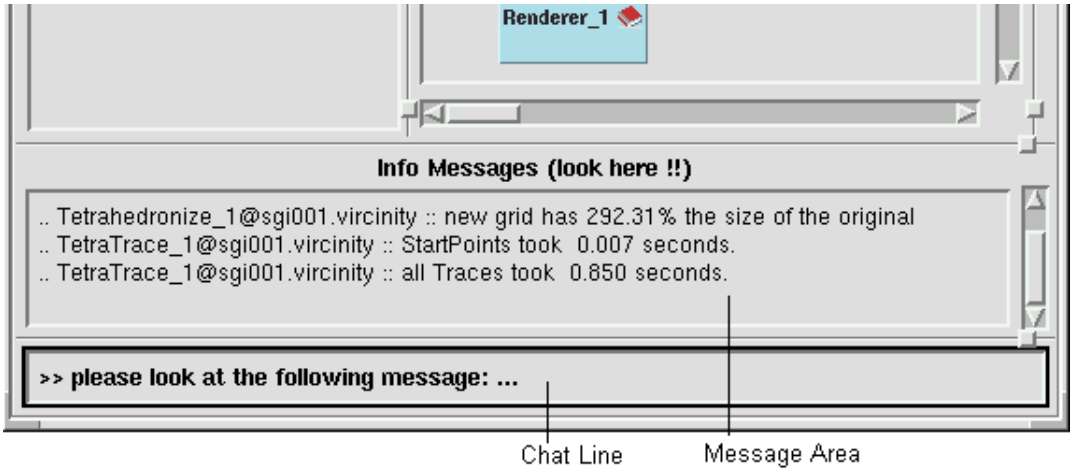

Renderer_1
Info Messages (look here !!)
.. Tetrahedronize_1@sgi001.vircinity :: new grid has 292.31% the size of the original
.. TetraTrace_1@sgi001.vircinity :: StartPoints took 0.007 seconds.
.. TetraTrace_1@sgi001.vircinity :: all Traces took 0.850 seconds.
>> please look at the following message: ...
Chat Line
Message Area

Figure 6.14: Message Area and Chat Line

The **Message Area** is a scrollable text output window (lower part of Map Editor window) that shows warning and information text produced by modules during their execution. In addition, this Message Area can be used for receiving information sent from other partners. The **Chat Line** is an editable text field (below the Message Area) that can be used for sending information to other partners joining a COVISE session. After pressing ENTER, the contents are sent to all other message areas of the participating user interfaces. A beep happens on the receiving host, and the information text is highlighted (reverse video mode). The layout of these messages is

```
>> hostname >> Text
```

6.4 Performance Considerations in a Cooperative Session

Particularly for performance reasons, it is advantageous to know little about what is going on behind the scenes when the mouse is moved around in the viewer area, especially when working with the master renderer in the environment.

6.4.1 Updating the Telepointer

The telepointer is operating in all directions. If you press the SHIFT key on your keyboard, your machine's name will appear at your current mouse position in the other renderer's drawing areas. To reposition the telepointer to another position, release the SHIFT key, move the mouse and press SHIFT again at the new position, or move the mouse while the SHIFT key is still pressed. The difference here is, that in the second case the new mouse position is sent over the network very often.

6.4.2 Direct Manipulation

Normally, new positional information is only sent, when the master releases the mouse button in the viewer area.

6.4.3 Using the Decoration Around the Viewer Area

The same is true for the thumb wheels and the slider around the viewer. When you release the mouse button information is sent over the network.

6.4.4 Using Sliders

As far as the sliders in the transform editor are concerned, the situation is somewhat different. If you are using the transform sliders by pressing the mouse button and moving back and forth, every little movement will directly go over the network. If you want to avoid this, click on the slider once at the desired position or use the input line. Note that renderers running on machines without advanced graphics hardware can manually change the scene drawstyle changed to wireframe or points for locally doing extensive editing operations. This especially applies to the master/slave mode.

6.5 Mirroring

6.5.1 Mirroring Summary

After reading this chapter you will be able to work with a "mirror" of your map.

The main purpose of mirroring is to show a map in a slave without copying huge amounts of input data.

COVISE allows you to "mirror" a whole pipeline (also distributed) or parts of it completely to another host (and to delete it):

- **Set Mirrors** - Sets the mirror for each host in the session
- **Mirror Node** - Mirror nodes (modules) of the current map to the chosen mirror host
- **Delete Mirrored Nodes** - Delete all mirrored nodes (modules); the original map remains unchanged

You can set new mirrors and add more hosts (see next 3 sections with a simple - not realistic - example). For a motivation to use mirroring see the realistic example in the last section.

6.5.2 Set Mirrors

In order to **Set Mirrors**, you should have added at least one partner/host; in case of the example below you are working as user "covise@sgi002.vircinity.de" and you have added "pw_te@sgi001.vircinity.de" as a partner. You can specify now sgi001.vircinity.de as mirror of sgi002.vircinity.de (and sgi002.vircinity.de as mirror of sgi001.vircinity.de).

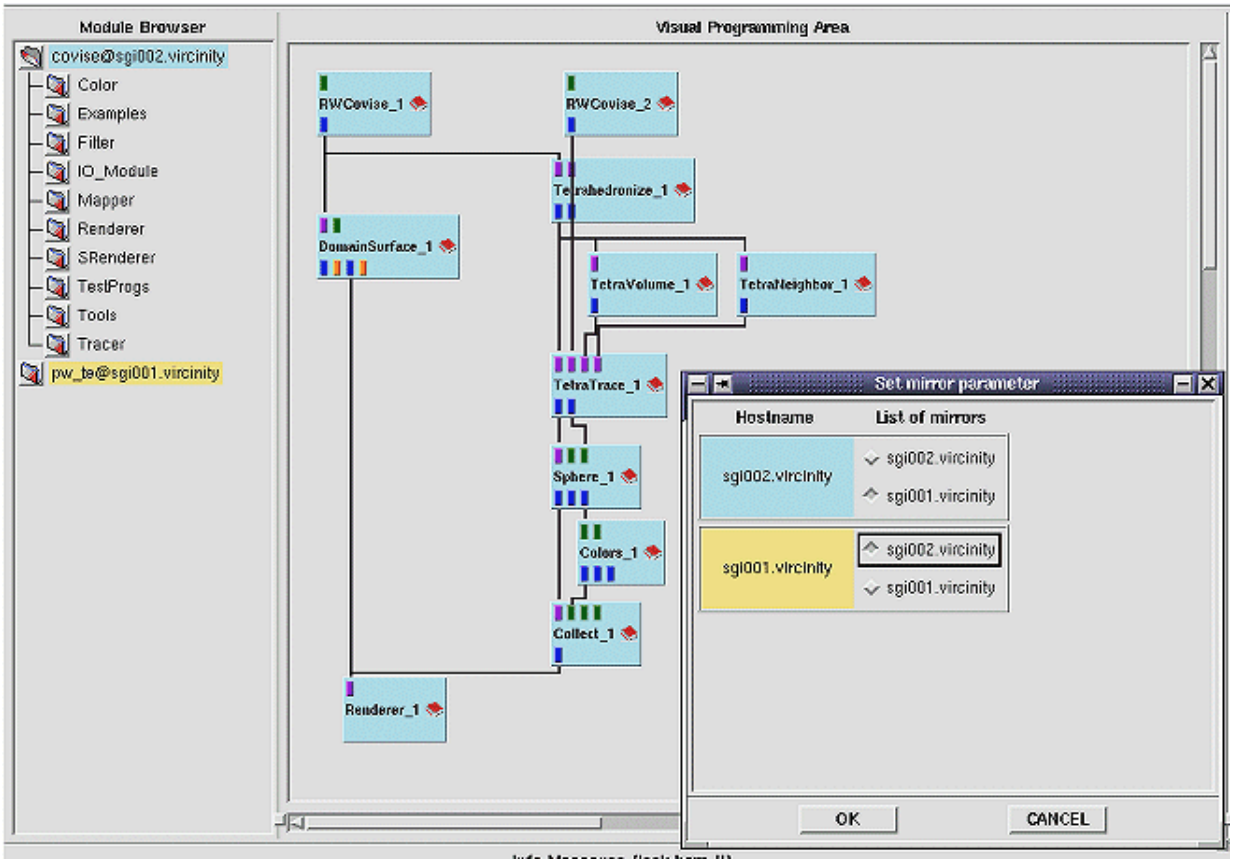


Figure 6.15: Set Mirrors

6.5.3 Mirror Nodes

If you have set mirrors, you can issue **Mirror Nodes** in order to mirror either a complete map (default) or a selected group of nodes.

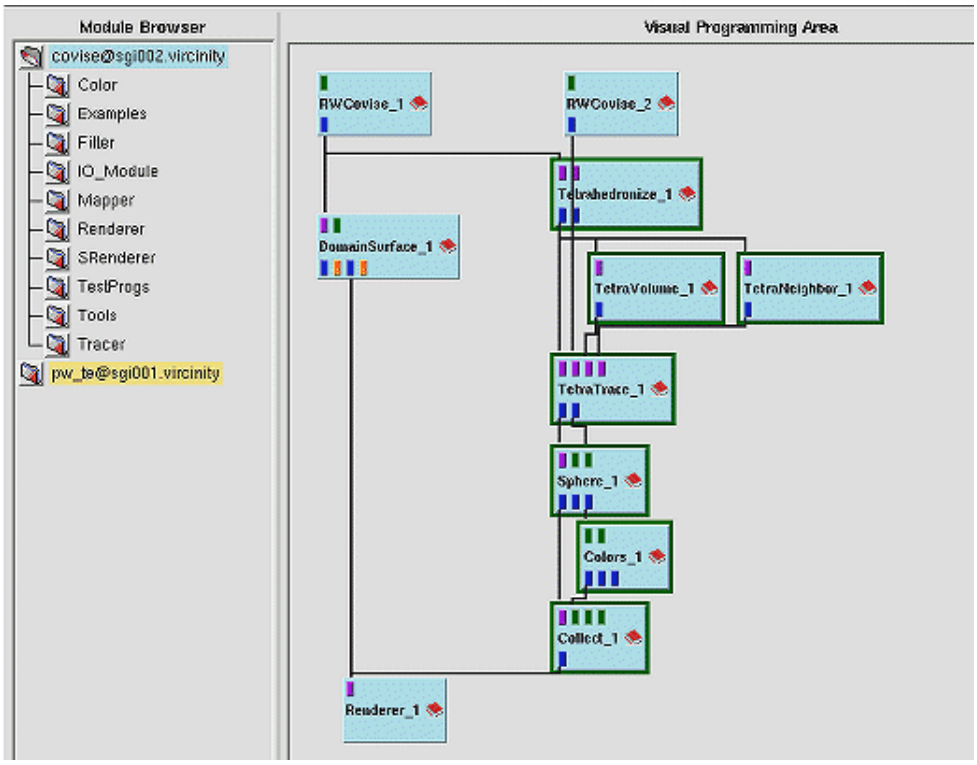


Figure 6.16: Mark nodes to be mirrored (default: complete map)

Now you can mirror the selected nodes (shown in yellow) and compare e.g. execution times of original and mirrored modules. In the example below you see that the mirrored modules run faster, so you might choose to change your map accordingly.

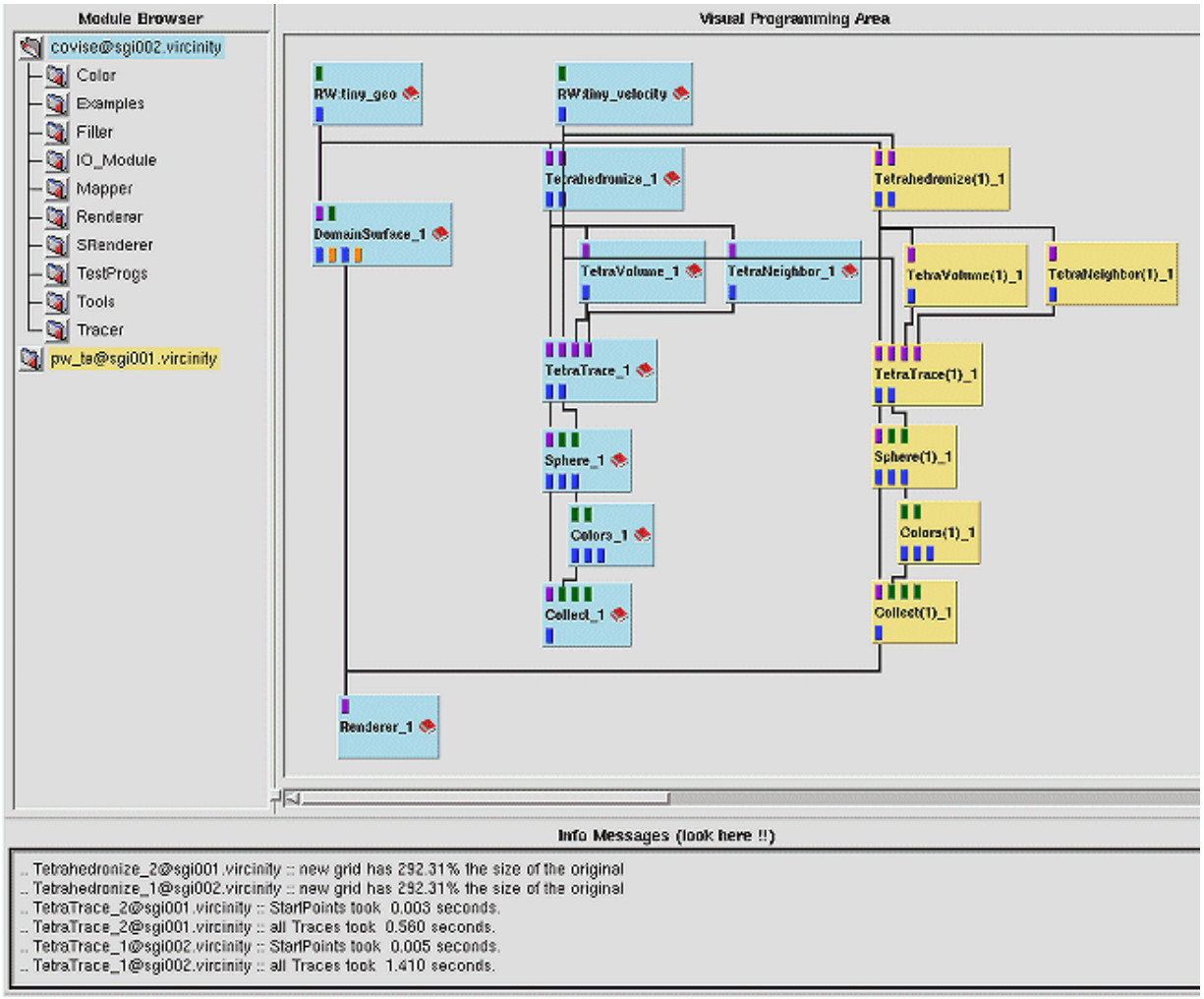


Figure 6.17: Mirror nodes (and compare execution times)

6.5.4 Delete Mirrored Nodes

Delete Mirrored Nodes is just the inverse operation of **Mirror Node**, i.e. it removes the mirrored nodes and leaves your original map unchanged.

6.5.5 Example

The advantage of mirroring modules to your partner's host is that you save the time of transferring the whole visualization data every time the object changes. Changing the camera position in the renderer doesn't change the visualization data itself. Therefore if you only use functions of the Renderer, the visualization data will not be transferred multiple times. You don't need the Mirror mode feature in this case. But if you really want to change the visualization data during the session you should use this mode. For example if you want to change the data mapped on the surface from temperature to pressure you can take advantage of the mirror mode.

Suppose you want to share the visualization of a crash with your partner. The data has 53 time steps and the whole data size including all these time steps is 20MB. It was computed with 54.800 elements. Assume you use an ISDN line and can transfer 8kB/s data in average. Then it takes around 43 minutes to transfer the data to your partner.

You are in the session now and you want perhaps just change the color map of your visualization to analyse a certain range of values. Do you really want to wait 43 minutes before you can continue the meeting?

The mirror mode solves this problem in the following way: You have to tranfer once your data to your partner's side. Every execution you do on your side is also done on your partner's machine. Therefore no visualization data has to be transferred. All changes are updated on both sides independently. You can see the status of execution on your partner's side in the Mapeditor.

NOTE: The path- and filenames of your data have to be identical on every machine! The easiest way to create this scenario is to put the data in your COVISE directory. All modules of COVISE allow the usage of path names that are relative the current COVISE directory.

6.6 New Collaborative COVISE (Daemon)

This chapter introduces a new concept of Collaborative COVISE that is more general and more flexible than using the CSCW operations AddPartner etc.

COVISE Rel. 5.2 provides a first implementation of this approach -

- **use this preversion at your own risk**.

Section 1 is a concept paper about this approach that provides the necessary background even if it might be obsolete in some details.

Section 2 shows you the implementation (your actual view might be slightly different).

Section 3 provides you the actual information to use the COVISE daemon "covised".

6.6.1 Concept of Collaborative COVISE

What's new?

The goal of this project is to improve the way of using COVISE in collaborative mode and provides the following features:

- every user has the information about his potential partners and is able to ask to be accepted into a certain group. Also, if he wants to show his work to the others, he is able to create a new group (we name it "room") where he is the master. In this case, the others can join or he can invite some partners or "force" the hosts to work together.
- the connection between partners is done once; every COVISE session has already this information and adds automatically the partners or hosts;
- the concept is able to handle firewalls.

Structure and Functionality

The management of the participants and conference rooms is done by a special application named **"covised"** (COVISE daemon). It can launched by every user and can be configured to run with or without user interface. Every daemon reads from a configuration file (.covised) a list of users he is interested in (masters list) and a list of predefined rooms. A room is a list of potential partners and is directly related to the user who created it (the master of the room) . It can be private (only the name of the room is propagated to the members), normal (the members are propagated but only inside the room - only this version is currently implemented) or public (the name of the members and the name of the room are propagated to everybody who asks).

```
Example of .covised file for user_x@host_j:

#Masters_list
  user1@host1
  user2@host2
   ...

#Rooms_list
Room1_user_x{
  user3@host3
  user4@host4
  user4@computeServer  host  "ssh hwwo2k 'covised -host user_x@host_j'"
  ...
 }
```

When the covised is launched it tries to establish first the connections with every user of his masters list. Some of them are already connected and ready to inform him about the rooms where they take part (entire list of potential participants and those who already work together with a different color). If there are some predefined rooms in his list (he is the master), the application will try to connect to all potential members of the room(s) and if they run covised and he is included in their masters list, a (info) connection will be established and the information about rooms will be sent.

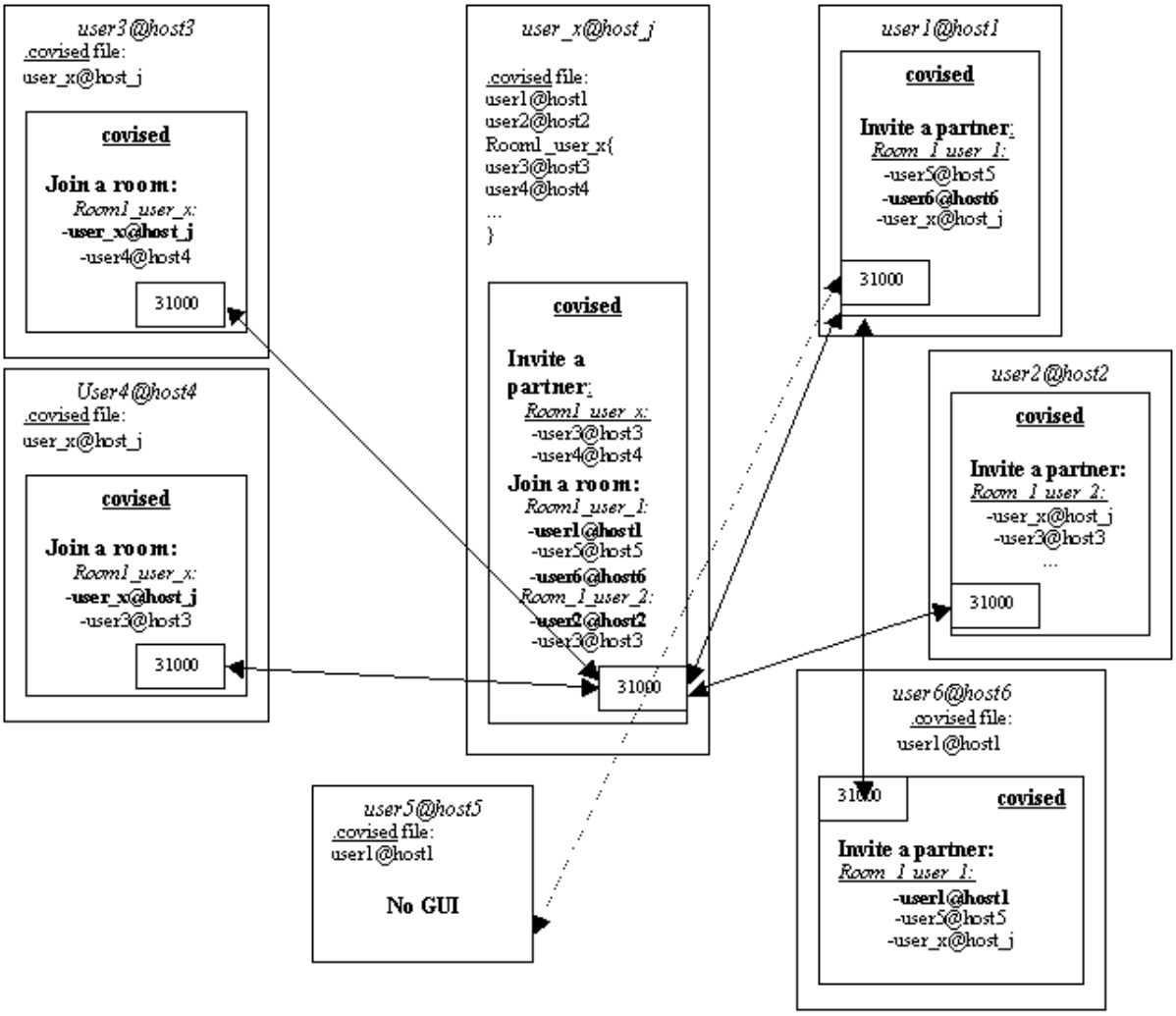


Figure 6.18: Concept of Collaborative COVISE

This is the first step: obtaining the informations about rooms and partners, and it is done automatically by the application opening some permanent connections between the members who have launched covised ("passive members"). That does not mean that they already work together: they need to be invited or to ask to be accepted to become an "active member" of a certain room. In the figure above, the user1@host1 which is not the master of the Room1_user_x is also displayed with different color because he was invited by the user1, he accepted the invitation and he is considered now an active member (and the option "Join a room" will be transformed into "Invite a partner" for the same list). When the user_x wants to join the Room1_user_1 (double click on the room), a request will be sent to the master, which will accept (send a message to all connected members of the room: user6, user_x) or will refuse the request (sending a message to user_x).

A special situation is with the user5 who does not not have an user interface. In this case he will try to connect to user1 (read from .covised) and will become automatically an active member of the rooms which are defined by user1 (Room_1_user_1) and include him as member.

The non-GUI covised will also be used if there is a firewall between host1 and host5, for example, and host5 can be used as "host". user1 opens a secure shell (ssh) on host5, launches covised without GUI but with an argument "-host". The connection between daemons will be done and a COVISE session will add automatically user5 as "host". If the host is defined in the .covised file, the daemon could also be started automatically by a command in the file as shown in the example file for user4@computeServer.

But the final goal of the users is to have a collaborative COVISE session. It will be launched by the master (does not matter the number of active members), which will press a button attached to the room. The controller, crb and MapEditor will be launched and if there are already some active members, a crb command will be generated (as in manual "AddPartner") and will be transmitted through the directly opened connection to their covised, which will launch the crb, and everything will work as in old collaborative covise. As soon as there are new active members they will be added automatically as partners.

An active member can quit by asking the master or can be eliminated by him. An automatic "remove partner" will be done in the COVISE session, but the connection will be kept because he is still a passive member. An exit from collab_covise will also close the connection. For detecting crashes, there will be an exchange of messages between the master and slaves every 30s.

Multiuser Concept

If there is more than one user on the same machine running covised, the usage of a fix port (31000) is not sufficient. The first process, which accepts connections on 31000, will route, in this case all, messages between other users and their partners. If a new user on the same machine launches covised, it will connect to 31000 for sending or receiving messages to or from outside through the first user.

If the first user terminates covised or crashes, his role should be taken by another daemon of another user. For doing that, there will be a priority list (FIFO principle) which will be sent to all local users. When the "owner" of 31000 will exit, the first in the list will listen to 31000 and the others will connect there.

6.6.2 Implementation

The pictures below show you an example of the implementation of Collaborative COVISE with "covised" (Your actual view might slightly differ from the images shown below).

There are 2 members

```
 covise@sgi001
 covise@sgi001
```

and the following configuration of rooms

```
active:     Room 2 - Master: active members covise@sgi001 and covise@sgi002

potential: (Room 1 - Master)
            Room 3 - Master: potential member covise@sgi001
(see Fig. 5.20)

active:     Room 2  - Slave: active members covise@sgi001 and covise@sgi002
           (Room 2X - Master)
potential: (Room 1X - Master)
            Room 3X - Master: potential members covise@sgi002 and covise@sgi001
(see Fig. 5.21)
```

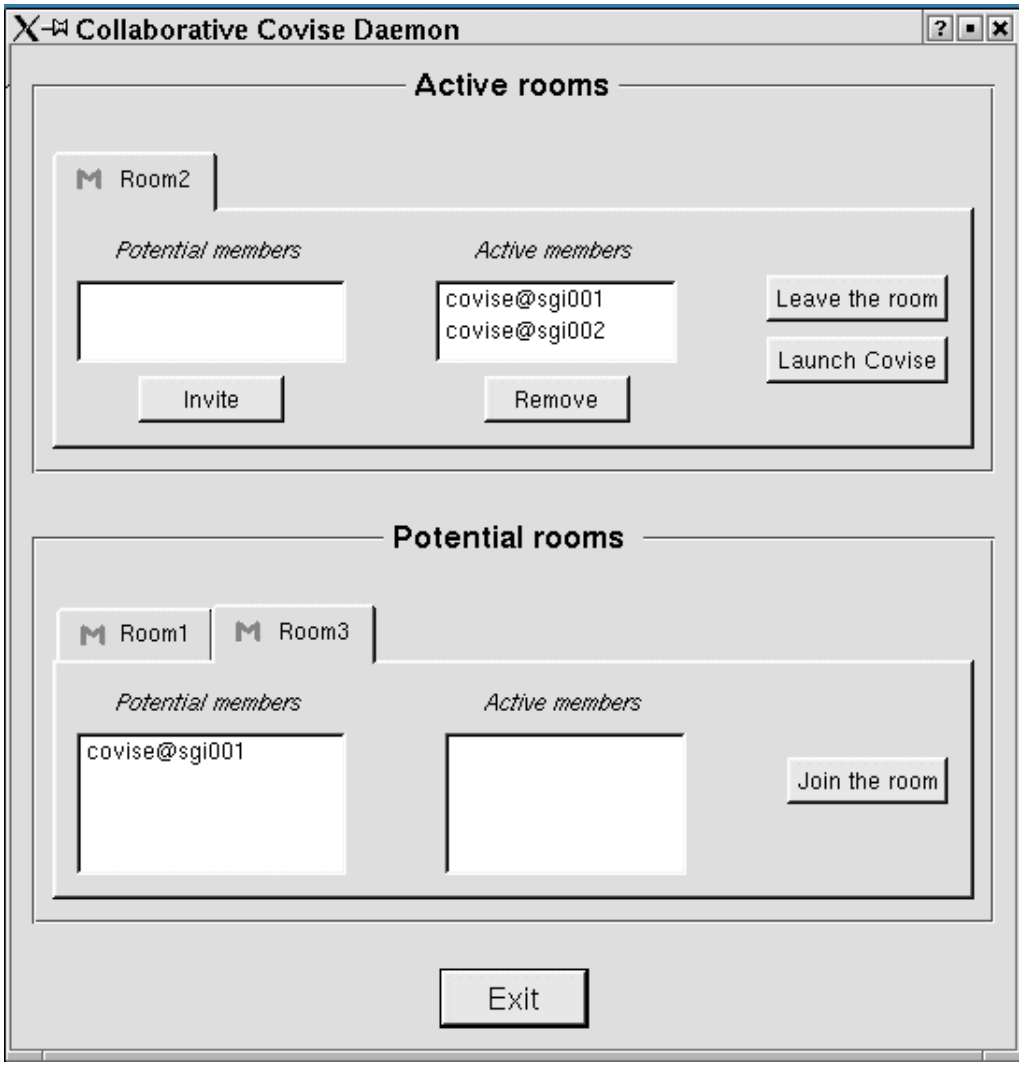


Figure 6.19: active: Room 2 - Master / potential: (Room 1 - Master) Room 3 - Master

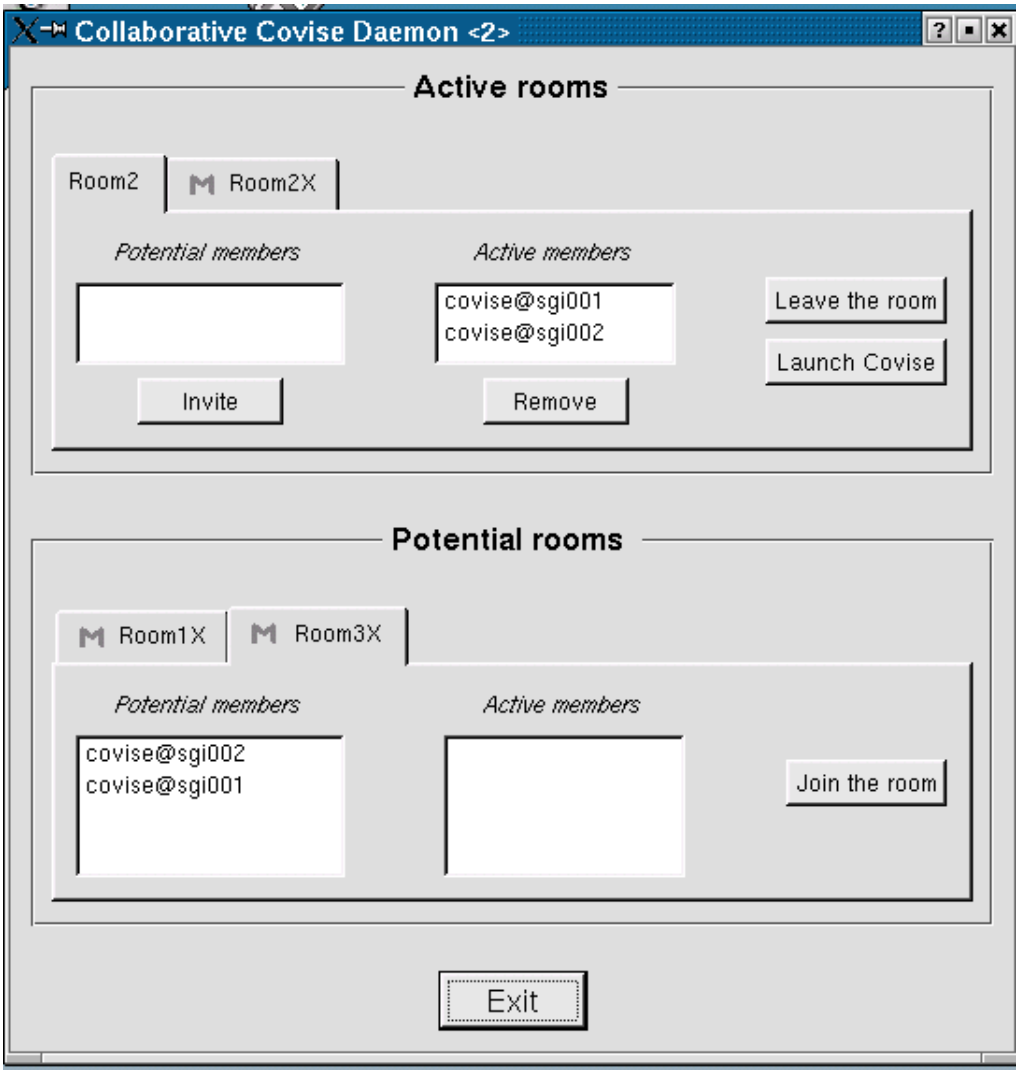


Figure 6.20: active: Room 2 - Slave (Room 2X - Master) / potential: (Room 1X - Master) Room 3X - Master

6.6.3 Instructions for using the COVISE daemon

The following section provides you the necessary information how to use the COVISE Daemon ("covised") as a comfortable and more powerful replacement of the CSCW menu in the MapEditor.

Introduction to the COVISE daemon ("covised")

- Function:
  The COVISE Daemon "covised" is a special software which allows the creation of working groups of COVISE users in collaborative mode.
- Terminology:
  - The working groups are called "rooms". They are used for sharing information within a COVISE session.
  - The user who has created/predefined a working group is called "master" of this room (working group)
  - Any user who is in the list of available partners for a defined room is called "member" of this room.
  - Rooms can have two type of members, displayed in separate lists:
    - "Active members" are the members which have joined the room in order to participate in a COVISE session.
    - "Potential members" are the members which have started a "covised" session but have not yet joined the room.
  - When launching a "COVISE" session in one of the defined rooms, the main part of "COVISE" is started for the user which is the "master" of the room. For the other users from the list specified for that room, "COVISE" is started in "partner"—"host" mode.

Using the COVISE daemon ("covised")

In order to use the COVISE daemon "covised" the following operations are provided:

1. Prepare the environment for using "covised":
   Before starting "covised", an initialization file can be prepared. The name of the file has the following format: ".covised[-hostname]", where "hostname" is optional.
   The initialization file has two sections :
   - #MASTERS_LIST section with the names of the users and hosts to which covised tries to establish connection
   - #ROOMS_LIST section which contains predefined working groups established for using COVISE in collaborative mode.
2. Start a "covised" session:
   - After the start, "covised" tries to establish connections to the COVISE daemons started by the other users specified in the #MASTERS_LIST section.
   - After connecting to the users from the "#MASTERS_LIST", covised tries to establish connections to the members of the rooms defined in the initialization file but not yet connected.
   - If the connection is established the process of exchanging the available "rooms" is started in both directions. The "rooms" are sent only to the users which are members of those "rooms".
3. Create active rooms:

- After covised has been started the available rooms including the members to which connection has been established are displayed in the room list. The rooms created by the user who has started "covised" have a "M" icon on the left side of the room name. The rooms received by connected partners don't have this icon.
- If the master of the room joins a room by clicking on "Join", the room becomes an "active" room and is displayed on the upper part of the covised user interface. Only the active rooms are sent to the partners.

4. Start a COVISE session:
   - Click on "Launch":
     A COVISE session is started including all the active members of the room.
5. Invite a partner:
   - Select a potential member of the room and click on "Invite":
     The selected member becomes an active member of the room. If a COVISE session has already been started the selected member is included in the session.
6. Remove a partner:
   - Select an active member of the room and click on the "Remove":
     The selected member becomes a passive member of the room. If a COVISE session has already been started the selected member is removed from the session.

6.7 Web Interface

Please note: This feature is included as a preversion and with draft documentation - use at your own risk!

The web_interface allows a web user to display in his browser the current renderer view from a running covise session. In order to do that execute the following steps:

1. Set the configuration file "init.www" :
   This file contains the next environment variables which have to be set :
   - HOSTSRV - the name of the host where the web server is running
   - SERVER_PATH(optional) - the path where the files needed to run the web interface are stored
   - HTTP_PORT - the number of the port on which the web interface is accessed from a web browser
   - COVISE_PORT - the number of the port on which the web interface is accessed from the COVISE session

   IMPORTANT:

   Before starting the web_srv, a COVISE session, or stopping the web_srv, the environment variables have to be set using command "source init.www"

2. Start the web_interface :
   - execute command web_srv
   - if the following error is displayed

     ```
     ERROR: bind to port : xxx ...
     ```

     (where xxx is the port number of the HTTP_PORT or COVISE_PORT) the corresponding port (HTTP_PORT or COVISE_PORT) should be changed to a new value. Set the corresponding environment variable to the new value and restart the web_interface.
3. Access the web_interface :
   - Using a a browser with a VRML plug-in installed (for example CosmoPlayer) the user should access the following URL address:

     ```
     http://HOSTSRV:HTTP\PORT/ClientApplet.html
     ```
   - The web page displayed will contain a display area for VRML objects and a list of "registered renderers". This list contains the identifiers of VRML renderers connected from covise sessions.
   - The user can select one of the available VRML_renderers, and by using Connect button the objects stored in the VRML renderer are displayed in the browser.
   - By selecting the "dynamic synchronization" option, the changes of the objects from the selected VRML renderer are also shown in the browser. If the user wants to interact directly with the objects displayed in the browser then he should deselect this option. To restore the synchronization with the COVISE Renderer the COVISE viewpoint should be reselected and the synchronization option reactivated. (After interacting with the objects in the browser area the name of the viewpoint is displayed with different fonts)
4. Use COVISE with the web_interface;
   - In the COVISE session the objects you want to display in the browser have to be connected to the VRML renderer module.

- For interaction with the objects the IVRenderer module has to be used with the same input objects connected to the VRML renderer. If the web user allows synchronization with the renderer the changes made by user in the IVRenderer are transferred to the web browser.
- In the COVISE session one pair of the IVRenderer/VRML_renderer modules can be used. If a new map is opened in covise session the identifier of the new VRML_renderer is sent to the browser.

5. Stop the web_interface:
   - execute command

     ```
     tsc_client
     ```

7 Batch Processing in COVISE

The **Batch Processing** function has been provided together with COVISE version 5.3.1., and this Appendix provides a short introduction to (actual a presentation of) this topic.

7.1 What does Batch Processing mean?

- **Historically:** A term from the early age of computing: A stack of input-decks (the program) was brought to an operator to be processed.
- **Today:** A set of commands which covers the whole functionality of a software to be processed without a Graphical User Interface (GUI)

7.2 Applications

User:

- Creation of individual converters.
- Preparation of huge data-sets for interactive analysis (VR) or presentations. Typical tasks: Cutting (CropUSG), Sampling (Sample), Assembling (BlockCollect)...
- Specific animations.

Developer:

- Testing
- New applications
- Rapid prototyping

7.3 Implementation

New user interface: the command-line

Language used: PYTHON

Advantages of Python:

- Open source **(www.python.org)** and widespread in scientific computing
- Comprehensive syntax
- Rich on features (object orientation, huge package-library)
- extensible

7.4 Mapping of COVISE to PYTHON

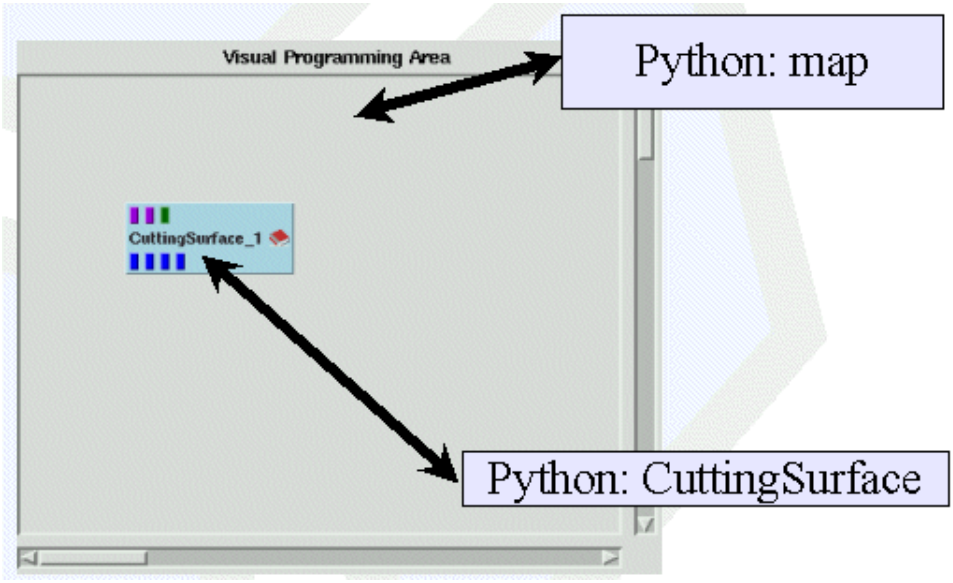


Figure 7.1: Mapping of COVISE to PYTHON

Rule: Each module on the map-editor corresponds to an object in Python; the map itself translates to an object called **net**

7.5 How to begin?

Run Python-interface by typing: covise – script [filename]

```
[gromit|SNAP] ~ > covise -- script

************************************************************
* COVISE 5.4_a1 starting up, please be patient....          *
* Flexlm license of type STD_UI checked out...              *
*                                                           *
* Starting local request broker...                          *
* Starting user interface....                               *
*  ******* COVISE PYTHON INTERFACE ********                 *
* ...done initialization                                    *
************************************************************
  COVISE PYTHON INTERFACE ready

covise>
```

Note: Using the Python Interpreter provided by your Vendor

On some Linux distributions incompatibilities between existing libraries and the python interpreter included in covise may occur. In those cases using the python interpreter provided by your linux distributor can resolve the problem. Known are incompatibilities at SuSE 9 and Mandrake 9.0 systems.

In order to circumvent those problems do:

- Find out if python is already installed on your system:

  ```
  rpm -qa | grep python
  ```

  should show you that the package is installed. If not, install python according to the rules of your distribution. The packages are currently included in all known linux distributions.
- Find the path to your python binary by typing 'which python'
- Set the environment variable COVISE_LOCAL_PYTHON to the result of the previous command (/usr/bin/python in many cases).

After entering covise –script you should receive the following output:

```
************************************************************
* COVISE 5.3.2 starting up, please be patient....           *
* Flexlm license of type STD_UI checked out...              *
*                                                           *
* Starting local request broker...                          *
* Starting user interface....                               *
* using local python interpreter  /usr/bin/python
*  ******* COVISE PYTHON INTERFACE ********                 *
* ...done initialization                                    *
************************************************************
  COVISE PYTHON INTERFACE ready

covise>
```

On some systems you might obtain a warning like:

```
RuntimeWarning: Python C API version mismatch for module _covise: This Python
has API version 1012, module _covise has version 1011
```

In most cases you can ignore this warning but nevertheless it is recommended to check the proper functionality by converting an example COVISE map with the tool map_converter:

```
map\_converter -P -o converted.py $COVISEDIR/net/tutorial/channel.net
```

and run the resulting python-script in COVISE-python by typing the command

```
covise --script convertedNet.py
```

In case problems occur due to version incompatibilities of covise and the version of python provided by your linux-distributor please contact support@visenso.de.

7.6 Python syntax

7.6.1 Not COVISE related:

```
covise> a=3
covise> b=14
```

——— *Assignment*

```
covise> print a+b
17
```

——— *Output*

```
covise> i=0
covise> for i in range(0,3):
...     print i
...
0
1
2
```

——— *Loop*

```
covise> s="hello World"
covise> print s
Hello World
```

——— *String*

Comprehensive tutorial:
http://www.python.org/doc/2.2p1/tut/tut.html

7.6.2 COVISE-related:

```
covise> myNet=net()
```

——— *Create a net object - implicit after opening the map-editor*

```
covise> rin=RWCovise()
```

——— *Create a RWCovise object*

```
covise> myNet.add( rin )
```

——— *Add module to the net - drag RWCovise module to the visual programming area (VPA)*

```
covise> rin.showParams()
  set_grid_path( x )
```

——— *Utility function*

```
covise> rin.showPorts()
mesh_in
mesh
```

```
covise> rin.set_grid_path("share/covise/example-data/COVISE/airbag.covise")
```

——— *Set parameter*

```
covise> render=Renderer()
```

——— *Create Renderer module*

```
covise> myNet.add( render )
```

——— *Add Renderer to net - drag Renderer to the VPA*

```
covise> myNet.connect(rin, "mesh", render, "RenderData")
```

——— *Create connection between modules*

```
covise> runMap()
```

——— *Guess what–* (-;

7.6.3 Mapping rules: COVISE - Python

- The Visual Programming Area is represented by the object net()
- Each COVISE-module is represented by a Python object of the same name: Renderer →Renderer()
- Each parameter of a COVISE-module is mapped by a member-function with the prefix set_

Example:

```
covise> re=ReadEnsightNT()
covise> re.showParams()
  set_case_file( x )
  set_data for sdata1( x )
  set_data for sdata2( x )
  set_data for vdata1( x )
  set_data for vdata2( x )
  set_choose_parts( x )
  set_repair connectivity( x )
```

Note:
Due to technical reasons you MUST set a parameter after you have added the module to the network!

7.6.4 Details of the Python net() object:

```
myNet.add( module )
```

——— *Add module to net*

```
[ mynet.remove( module ) ]
```

——— *Remove module from net*

```
myNet.save( filename )
```

——— *Save module into a COVISE net file*

```
myNet.connect( module1, portName1, module2, prtName2 )
```

——— *Connect two modules*

```
myNet.finishedBarrier()
```

———- **Wait until all modules have finished their work !!**

7.6.5 Details of the Python module objects:

- Parameter methods
- Utility methods

```
module.showParams()
```

```
module.showPorts()
```

Note:
Due to technical reasons you MUST set a parameter after you have added the module to the network!

7.7 One step forward - one step back

COVISE-net file to Python:

```
map_converter -P -o myFile.py myFile.net
```

Example airbag.net:

```
#
#   converted with COVISE (C) map_converter
#   from /home/ralfm_te/covise_snap/net/examples/Airbag.net
#
# create global net
#
theNet = net()
#
# MODULE: RWCovise
#
RWCovise_1 = RWCovise()
theNet.add( RWCovise_1 )
#
# set parameter values
#
RWCovise_1.set_grid_path( "share/covise/example-data/COVISE/airbag.covise" )
#
# MODULE: Renderer
#
Renderer_1 = Renderer()
theNet.add( Renderer_1 )
#
# CONNECTIONS
#
theNet.connect( RWCovise_1, "mesh", Renderer_1, "RenderData" )
#
# uncomment the following line if you want your script to be executed after loading
#
#runMap()
#
# uncomment the following line if you want exit the COVISE-Python interface
#
#sys.exit()
```

COVISE-net file to Python: use the save(fileName) method of the net() object